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EMISSION AND LEAK MONITORING PROGRAM

Chemical Processors, Inc. - Pier 91 Facility
(1/16/91)

USEPA RCRA



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INTRODUCTION

This "Emission and Leak Monitoring Program" is presented to comply with the regulations for "Hazardous Waste Treatment, Storage and Disposal Facilities - Organic Air Emission Standards for Process Vents and Equipment Leaks" [55 FR 25454], June 21, 1990.

The monitoring program is divided into six Sections; (1) Scope, (2) Monitoring Plan, (3) Repair Procedures, (4) Instrument Specifications and Calibration Procedures, (5) Recordkeeping Requirements, and (6) Equipment Service and Waste Analyses.

The Scope section presents the applicable regulations for appropriate portions of the facility. The Monitoring Plan describes the frequency and procedures used in monitoring for "leaks". The Repair Procedures describe the methods and time frames in which a discovered leak is repaired. The Instrument Specifications and Calibration Procedures provide documentation to verify compliance with EPA Method 21 requirements for monitoring instruments. The Recordkeeping Requirements section provides a description of the monitoring and calibration recordkeeping, and the semi-annual report requirements. The Equipment Service and Waste Analyses section provides a description of the types of waste contained in equipment at the facility.

Section 1 - Scope

This program is implemented to satisfy the regulations for "Hazardous Waste Treatment, Storage and Disposal Facilities - Organic Air Emission Standards for Process Vents and Equipment Leaks" [55 FR 25454], June 21, 1990.

The requirements for complying with the regulation are separated into two monitoring compliance programs (1) Emission Standards for Process Vents and (2) Equipment Leaks. To be subject to the emission standards for process vents, the facility must have distillation or stripping operations that process hazardous wastes with concentrations of organics greater than 10 ppm, and total vent flow is greater than 3 lb/hr or 3.1 ton/yr. The Pier 91 Facility has no distillation or stripping operations and is therefore not subject to emission standards for Process Vents.

To be subject to the equipment leak requirements, equipment must contain greater than 10 percent organics and be in hazardous waste operations or recycling operations adjacent to hazardous wastes operations. To satisfy the equipment leak requirements, specified equipment associated with Dangerous Waste tank systems are monitored for leaks according to the requirements for equipment in Heavy Liquid Service as described in Section 2, Monitoring Plan. Specific equipment subject to these regulations are shown on the monitoring forms presented in Appendix A.

Any leaks determined by monitoring are repaired as specified in Section 3, Repair Procedures and recorded as described in Section 4, Recordkeeping Requirements.

Section 2 - Monitoring Plan

Part 1 - Testing Requirements

Testing requirements are based on the equipment type and service. Equipment (excluding tanks and containers) which contain greater than 10 percent organics are monitored periodically according to the equipment type and service. The monitoring requirements for each equipment type are presented as follows:

1. Sampling Connection Systems:

Each sampling connection system must be equipped with a closed-purge system or closed-vent system and must be operated with "No Detectable Emissions" or vented to a control device.

2. Open-ended Valves or Lines:

Open-ended valves or lines must be equipped with a cap, blind, flange, plug, or a second valve.

3. Pumps and Valves in Heavy Liquid Service, Pressure Relief Devices in Light or Heavy Liquid Service, and Flanges and other connectors:

These equipment items are monitored to determine if a "Leak" exists, if there is evidence of a potential leak by visual, audible, olfactory, or any other detection method. "Leak" testing is performed within five days of discovering a potential leak.

Part 2 - Testing Procedures

These equipment items must be monitored for leaks within five days if evidence of a potential leak is found by visual, audible, olfactory, or any other detection method.

Procedures for testing consist of detection of "Leaks" (> 10,000 ppm Organics). The monitoring program is conducted using methods specified in 40 CFR Part 60 Appendix A, Method 21, "Determination of Volatile Organic Compounds Leaks". Monitoring frequency and type is shown in Table 1, Monitoring Requirements for Equipment.

"Leaks" Testing Procedure

1. Place the probe inlet at the surface of the component interface where leakage could occur.
2. Move the probe along the interface periphery while observing the instrument readout.
3. If an increased meter reading is indicated, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained and leave the probe inlet in that position for approximately two times the response time.
4. If the maximum reading is > than 10,000 ppm, a "leak" in the component has been identified. A maximum reading of < 10,000 ppm does not indicate a component leak.
5. Specific "Leak" Testing Requirements for Equipment Types are presented below:

(a) Valves

- Place the probe at the interface where the stem exits the packing gland and sample the stem circumference.
- Place the probe at the interface of the packing gland take-up flange seat and sample the periphery.
- Survey valve housings of multipart assembly at the surface of all interfaces where a leak could occur.

(b) Flanges and Other Connections

- Place the probe at the outer edge of the flange-gasket interface and sample the circumference of the flange.
- Sample other types of non-permanent joints (such as threaded pipe) with a similar traverse.

(c) Pumps and Compressors

- Conduct a circumferential traverse at the outer surface of the pump or compressor shaft and seal interface.
- If the source is a rotating shaft, position the probe inlet within 1 cm of the shaft-seal interface for the survey.
- If the housing configuration prevents a complete traverse of the shaft periphery, sample all accessible portions.

- Sample all other joints on the pump or compressor housing where leakage could occur.

(d) Pressure Relief Devices

- Place the probe inlet at approximately the center of the exhaust area to the atmosphere.

(e) Process Drains

- For open drains, place the probe inlet at approximately the center of the area open to the atmosphere.
- For closed drains, place the probe at the surface of the cover interface and conduct a peripheral traverse.

(f) Open-Ended Lines or Valves

- Place the probe inlet at approximately the center of the opening to the atmosphere.

(g) Seal System Degassing Vents and Accumulator Vents

- Place the probe inlet at approximately the center of the opening to the atmosphere.

(h) Access Door Seals

- Place the probe inlet at the surface of the door seal interface and conduct a peripheral traverse.

For identified "leaks", a visible weather proof identification number will be attached to the equipment item. The identification will not be removed from the

equipment item until it has been repaired and confirmed by monitoring.

TABLE 1: MONITORING SCHEDULE

EQUIPMENT TYPE	MONITORING FREQUENCY	CATEGORY OF MONITORING
Pressure Relief Devices (liquid service) Pumps & Valves (heavy liquid service) Flanges & Other Connections (all service)	When there is evidence of a potential leak found by visual, audible, or any other detection method.	"Leak"

Gas/Vapor Service: The piece of equipment contains or contacts a hazardous waste stream that is in the gaseous state at operating conditions.

Light Liquid Service: The piece of equipment contains or contacts a waste stream where the vapor pressure of one or more of the components in the stream is greater than 0.3 kilopascals (kPa) at 20°C, the total concentration of the pure components having a vapor pressure greater than 0.3 kPa at 20°C is equal to or greater than 20 percent by weight, and the fluid is a liquid at operating conditions.

Heavy Liquid Service: The piece of equipment contacts a waste streams that is not in gas/vapor service or in light liquid service.

→ as soon as practicable, but

Section 3 - Repair Schedule

Repairs to equipment must be completed within 15 days after the detection of a leak. A first attempt at repairing the leak shall be made within five days of detection of a leak. Delays for repair of the following equipment are allowed if the criteria presented below are met:

1. Delays for equipment repairs are allowed to avoid shutdown of hazardous waste unit or if the equipment is isolated from HW with >10% organics.

2. Delays for valve repairs are allowed if the emissions of purged material resulting from immediate repair of the valve would be greater than the emissions resulting from delays in repair, and the purged material is collected and destroyed or recovered.

3. Delays for pump repairs are allowed for changing to dual seal pumps, or if the repair is completed as soon as practicable.

Documentation procedures for repairs and confirmational monitoring is described in Section 5, Recordkeeping Requirements.

Section 4 - Instrument Specifications and Calibration Procedures

Part 1 - Instrument Specifications

Monitoring shall comply with Reference Method 21 in 40 CFR Part 60. The detection instrument, a Foxboro OVA 108, meets the performance criteria of 40 CFR Part 60 Appendix A, Reference Method 21.

The Foxboro OVA 108 is a portable VOC monitoring instrument which has a flame ionization detector. The meter reading of the instrument allows readings of 1 - 10,000 ppm VOCs in air. The meter scale is logarithmic and is readable to within 250 ppm at the high end of the logarithmic scale. The monitor is equipped with an electrically driven pump to allow a constant flow rate of approximately 2 liters/min. The Foxboro OVA 108 is FM and BASEEFA certified intrinsically safe for use in Class I, Groups A, B, C, and D, Division 1 hazardous locations.

Part 2 - Calibration

The instrument is calibrated before use on each day of use. Calibration gases shall be (1) zero air (less than 10 ppm of hydrocarbon in air), and (2) a calibration gas consisting of a mixture of methane in air at approximately, but less than, 10,000 ppm. The calibration gas is certified to be within \pm 2.5 percent accuracy.

Calibration procedures include the following:

1. Turn on the monitor and allow to warm up according to manufacturer's instruction.
2. Introduce the zero gas and zero the instrument to the zero concentration (ie. zero gas with 5 ppm methane should be zeroed at 5 ppm).
3. Introduce the calibration gas and adjust the instrument meter readout to correspond to the calibration gas value.

Part 3 - Performance Evaluation Requirements

Response Factors

A published list of response factors for the OVA 108 are provided in Appendix B - Monitor Information.

Calibration Precision Test

Calibration precision testing will be performed before each the analyzer is placed into service and at three month intervals or at the next use whichever is later. Jan ✓

The calibration precision test is performed by making a total of three measurements by alternately using zero gas and the specified calibration gas. The meter readings are recorded and the average algebraic differences between the meter readings and the known value is calculated. The average difference is divided by the known value and multiplied by 100. The result is the calibration precision presented as a percentage.

Response Time Test

Response time test is performed prior to placing the analyzer into service and after any modification to the pumping system or flow configuration.

The response time test is performed by first introducing the zero gas into the instrument sample probe. When the meter reading has stabilized, the calibration gas is quickly introduced. The time from switching to the calibration gas until the meter reading reaches 90 % of the final stable reading is recorded as the response time. This test is performed three times and the results are recorded. The average response time is then calculated and recorded.

Section 5 - Recordkeeping Requirements

Monitoring records of facility equipment will be kept on inspection forms, calibration forms, and repair logs.

Inspection Forms

The inspection forms consist of facility drawings identifying each piece of equipment with a number on the drawings. Those equipment items which require "leak" testing will have a space following the equipment number to designate whether the equipment item passes (P) or fails (F) the "leak" test.

Each equipment item will have a letter designation for equipment type followed by a three digit number to provide each item with an individual identification number. Pumps will be designated with the letter (p), valves with a (v), fitting (such as threaded elbows and flanges) with a (f), and pressure relief valves with a (prv).

When equipment monitoring has been completed, the forms will be maintained in the "Emission and Leak Monitoring Program" notebook at the facility.

Calibration Information

The required calibration information discussed in Section 4, Instrument Specification and Calibration Procedures, will be maintained in the "Emission and Leak Monitoring Program" notebook at the facility.

Repair Forms

When monitoring has been completed, these forms are kept on file in the "Emission and Leak Monitoring Program" notebook. Results for any leaks discovered during monitoring will be entered onto the repair request form. The repair request form will have columns to enter the following information:

- Operator name.
- Equipment identification number.
- The date evidence of a potential leak was found.
- The date the leak was detected and the dates of each attempt to repair the leak.
- Repair methods applied in each attempt to repair the leak.
- "Above 10,000" if the maximum instrument reading measured after each repair attempt is equal to or greater than 10,000 ppm.
- "Repair Delayed" and the reason for delay if a leak is not repaired within 15 days.
- Documentation supporting the delay of repair of a valve.
- The signature of the owner or operator (or designee) whose decision it was that repair could not be effected without a hazardous waste management unit shutdown.
- The expected date of successful repair of the leak if a leak is not repaired within 15 days.
- The successful repair date.

Modifications to Equipment

A description of each modification made to the equipment containing > 10 % organics will be kept in the "Emission and Leak Monitoring Program" notebook at the facility. The description will include the date of modification and a complete description of modifications made.

Examples of the monitoring forms and the repair documentation form are presented in Appendix A, Monitoring Forms.

Semi-annual Reporting Requirements

A semi-annual report may be required if leaks are not repaired within the time frame specified in Section 3, Repair Procedures. If a semi-annual report is required, the following information will be provided:

- EPA identification number,
- Name and address of the facility,
- For each month, the equipment identification number of each valve, pump, or compressors which was not repaired in the required time frame specified in Section 3, Repair Procedures, and
- Dates of hazardous waste management unit shutdowns during the semi-annual period.

A copy of all monitoring, repair, and modification forms will be kept on file with corporate Engineering.

Section 6 - Equipment Service and Waste Analyses

This program satisfies the monitoring requirements for determination and repair of "leaks" in equipment.

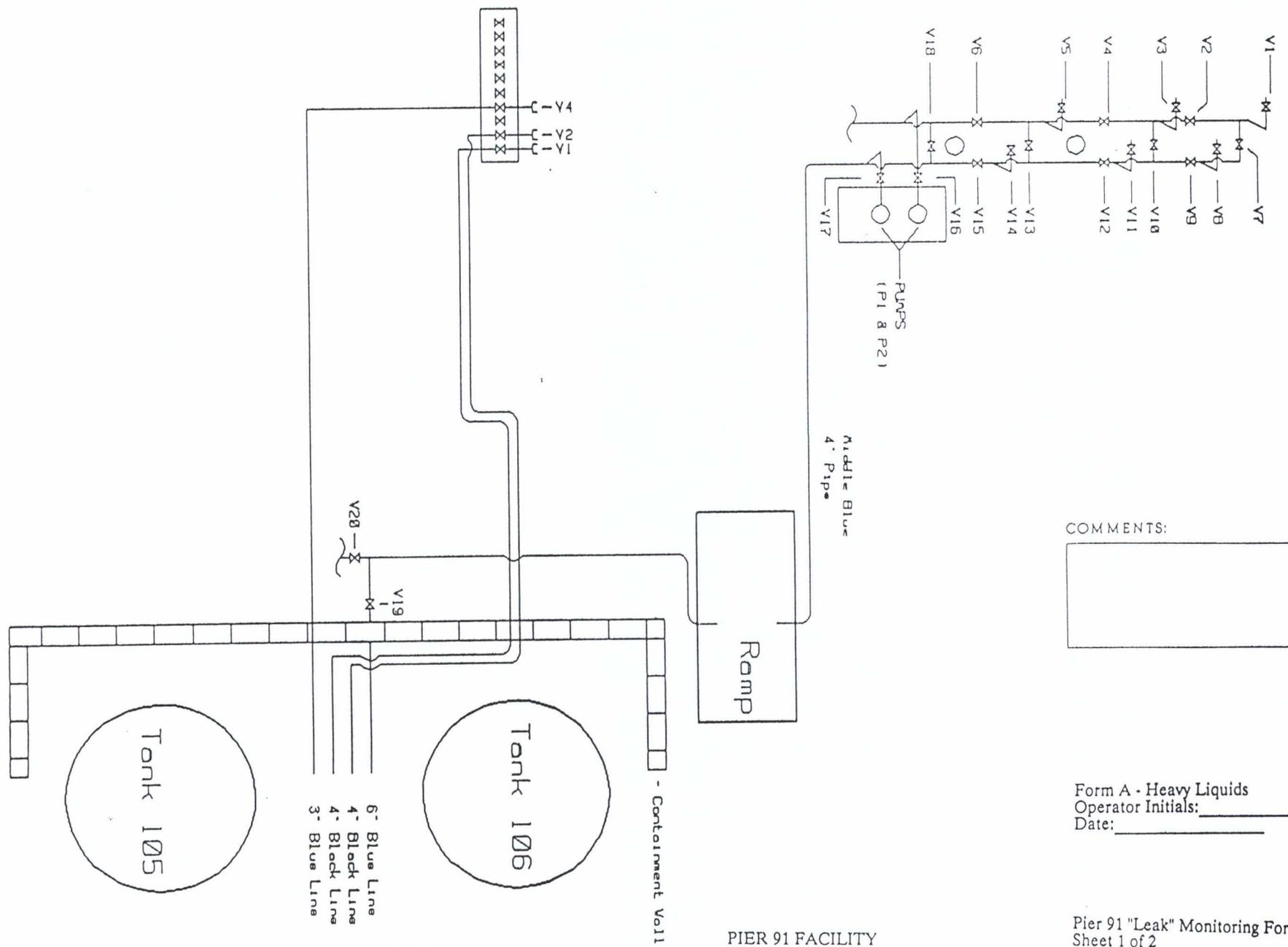
Equipment Monitored for Leaks

The equipment (excluding tanks) associated with operations at the facility that contain > 10 percent organics are monitored in accordance with the Section 2, Monitoring Plan. The specific equipment items required to be monitored are provided on the Monitoring Forms shown in Appendix A.

The general types of wastes received at the Pier 91 Facility containing greater than 10 % organics are waste oils and waste coolants with varying amounts of water. Dangerous waste tank systems at the facility are used for storage of dangerous waste and are subject to the permitting requirements of 40 CFR Part 270. Specific equipment regulated is shown on the monitoring forms in Appendix A.

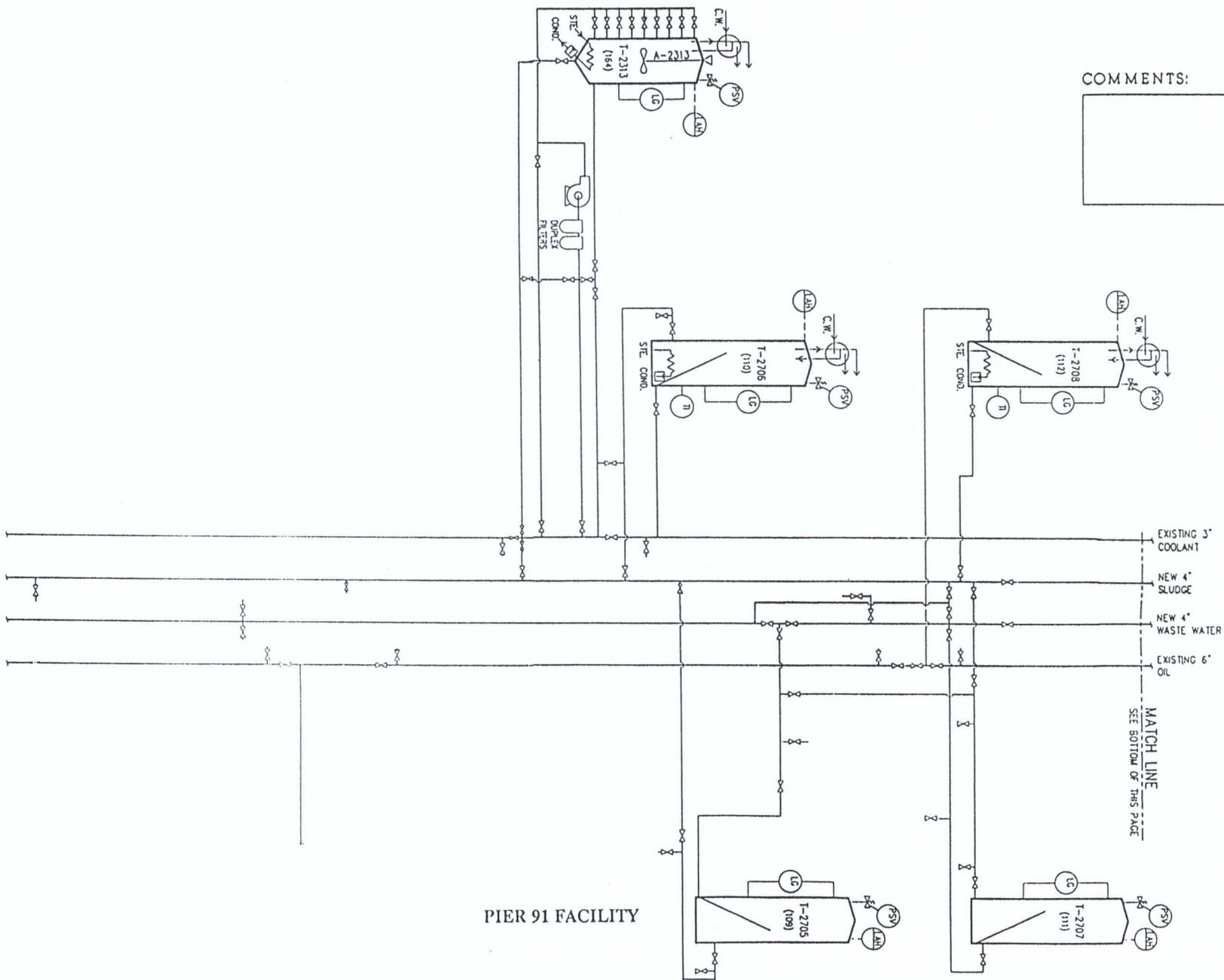
Examples of constituents of the wastestreams are presented in Appendix C, Typical Organic Wastestream Constituents.

APPENDIX A
RECORDKEEPING FORMS



COMMENTS:

Form A - Heavy Liquids
 Operator Initials: _____
 Date: _____



COMMENTS:

PIER 91 FACILITY

Form B - Heavy Liquids
 Operator Initials: _____
 Date: _____

Pier 91 "Leak" Monitoring Form
 Sheet 2 of 2

CHEMICAL PROCESSORS, INC.

Monitor Type: Foxboro Ova 108 (Serial # _____)

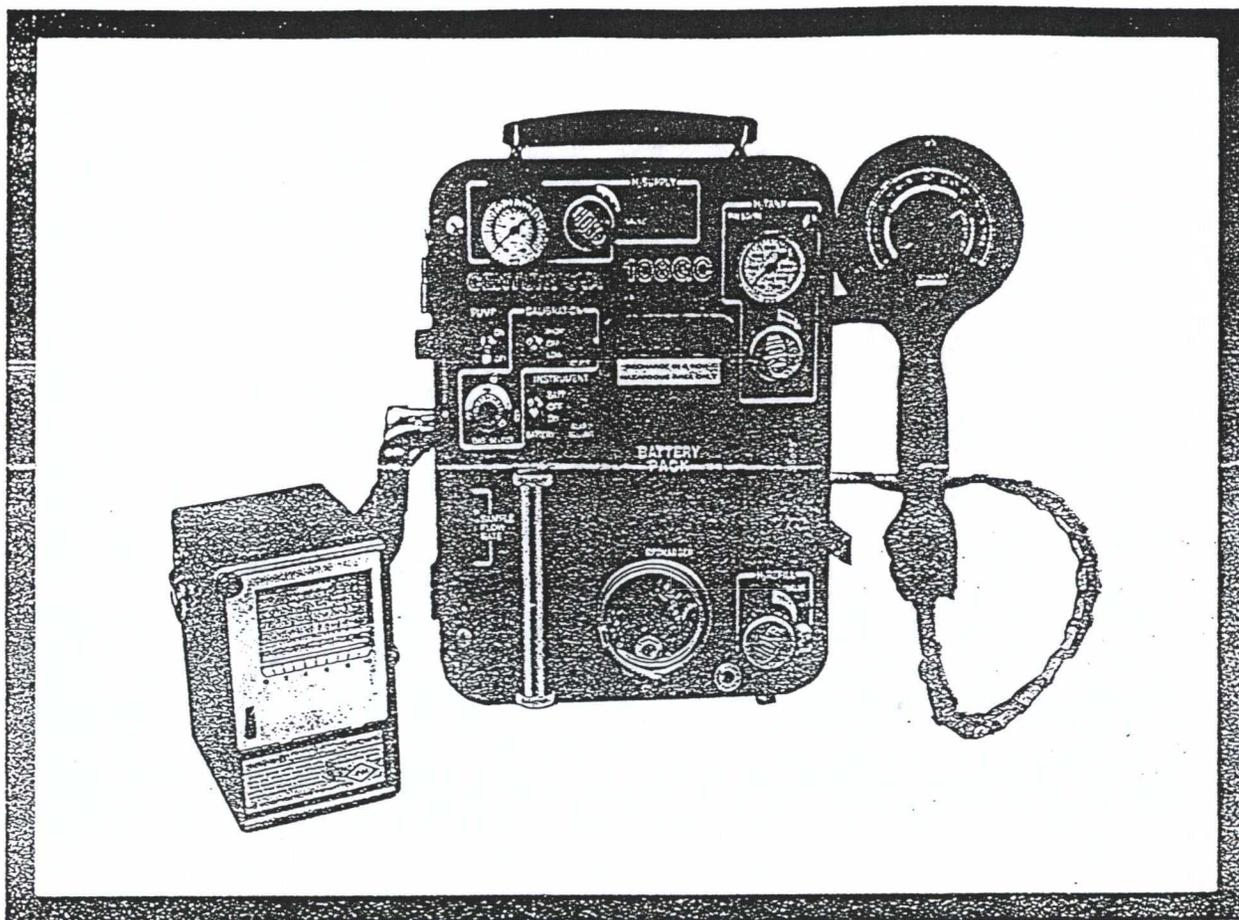
Calibration Precision Testing - Frequency: (3 months)

Zero Gas CH ₄ Concentration (ppm)	Calibration Gas CH ₄ Concentration (ppm)	Monitor Reading (ppm)	Average Difference (ppm)	Calibration Precision (%)	Individual Testing Name & Signature

Response Time Testing - Frequency: (When Placed in Service or After Modification to Flow System)

Zero Gas CH ₄ Concentration (ppm)	Calibration Gas CH ₄ Concentration (ppm)	Time Required to Reach 90% of Final Value (sec)	Average Response Time (sec)	Individual Testing Name & Signature
		_____		_____
		_____		_____

APPENDIX B
MONITOR INFORMATION



CENTURY OVA 108 PORTABLE ORGANIC VAPOR ANALYZER

The requirement for accurate and reliable environmental monitoring and leak detection is a high priority for industry. With the increased scope of environmental regulation, industry has a requirement for instrumentation that is application-oriented, and sufficiently flexible to meet changing needs. The dual mode CENTURY OVA 108 Portable Organic Vapor Analyzer is designed to meet these needs.

Several of the many OVA 108 features are

- Provides continuous, direct readout of total organic vapor concentrations for survey purposes (Mode 1)
- Allows qualitative and quantitative analyses using the gas chromatographic mode (Mode 2)
- It is a light-weight, completely field-portable instrument weighing approximately 5.5 kg (12 lb), that provides eight hours of continuous operation per battery charge.
- Attenuation of ranges is not required
- FM and BASEEFA certified intrinsically safe for use in Class I, Groups A, B, C, and D, Division 1 hazardous locations.
- Many hundreds of successful field-proven applications have demonstrated the exceptional reliability and ruggedness of this analyzer.
- Uses a flame ionization detector, which does not respond to ambient gases, such as CO and CO₂, and exhibits no sensitivity changes due to variations in relative humidity.

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INTRODUCTION

The CENTURY OVA 108 is a highly sensitive analyzer that allows the detection of trace quantities of volatile organics and still maintains a large dynamic range capability. Using a logarithmic scale, the OVA 108 analyzes organics from 1 to 10 000 parts per million (ppm). This range provides for both low and middle range concentration information important to general environmental monitoring. It also has the ability to monitor the high levels required for process leak detection.

DESCRIPTION

The OVA 108 is a dual mode analyzer combining the features of a continuous survey, direct reading instrument and a gas chromatograph. The survey mode allows the continuous monitoring of total organics to provide the rapid identification of airborne organics. These values are reported directly in ppm methane equivalent. Upon the identification of the "hot spots" or high concentration areas, the gas chromatographic mode can be utilized to further analyze the sample, separating and reporting the various organic materials present and their concentrations. This combination of analytical modes provides the best flexibility necessary to meet the environmental management needs of industry. The OVA 108 is an easy to operate instrument that is able to withstand and surpass the most demanding application use.

PRINCIPLE OF OPERATION

Flame Ionization Detector

The CENTURY OVA 108 utilizes a flame ionization detector to monitor the presence of organic vapors.

The principle benefits of monitoring with a flame ionization detector are:

- Universal organic compound response with approximately the same high sensitivity for all.
- Flame ionization will not respond to changes in relative humidity or changes in CO and CO₂ concentration.
- It is a mass sensing detector which exhibits minimal effects from changes in temperature, pressure, or flow.
- Provides excellent dynamic range and concentration linearity.

Sample gathering is done by using a small diaphragm air pump. Detection requires a hydrogen delivery system, a sample delivery system, and an electronic amplification and display system. The hydrogen delivery system provides an eight hour supply of hydrogen gas (with a precisely controlled flow) to the detector. The sample delivery system provides air to the detector chamber to maintain the flame combustion and introduce the organic air contaminants for analysis. Figure 1 illustrates both the hydrogen flow and air flow patterns in the OVA 108.

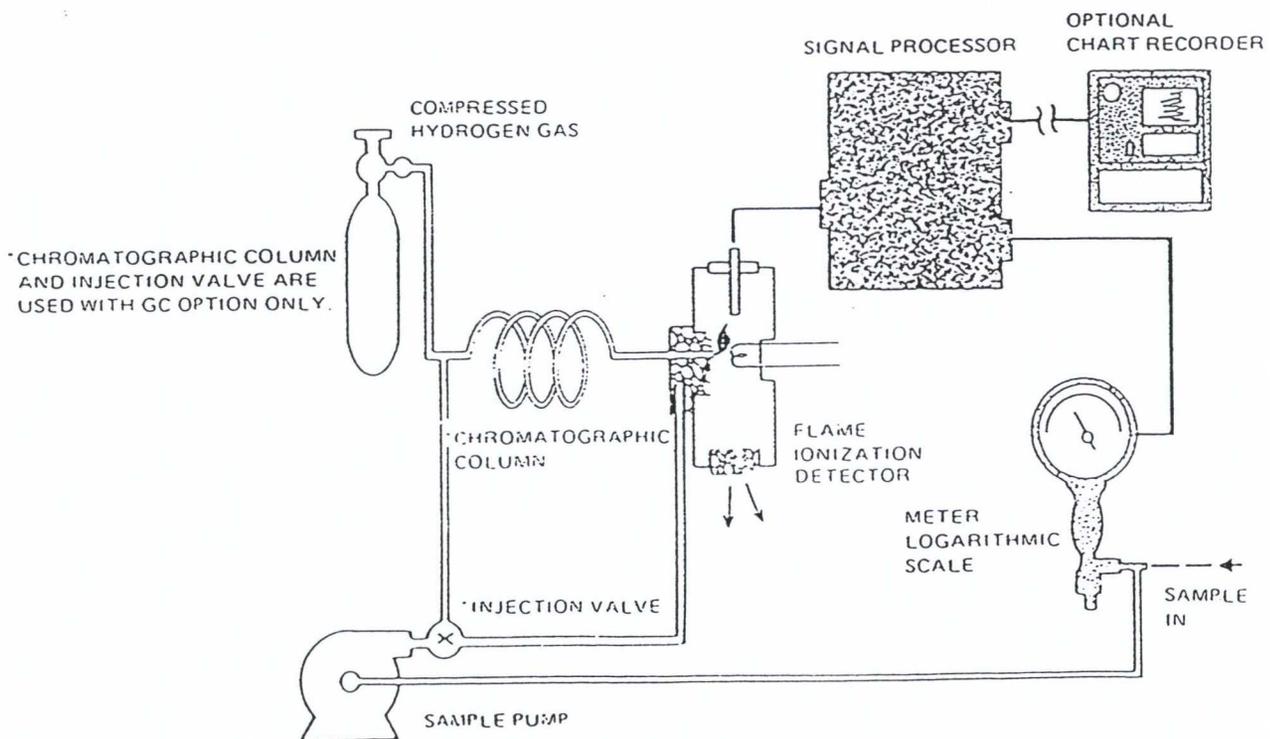


Figure 1. OVA 108 Schematic Diagram

Survey Analysis — Mode 1

In Mode 1, the air sample is delivered continuously to the detector chamber. When an organic vapor is exposed to the hydrogen flame via the air flow, the carbon molecules ionize and a current is carried between the detector electrodes. This current is proportional to the concentration of vapor in the sample. Different compounds will ionize to varying extents in the flame. The OVA 108 is internally calibrated for methane gas, and all survey responses are expressed in methane equivalent. The OVA 108 can be calibrated to read directly for other compounds, (for example, benzene) through the gas select adjustment dial on the instrument front panel.

Chromatographic Analysis — Mode 2

With Mode 2, the OVA 108 functions as a portable gas chromatograph utilizing hydrogen as a carrier gas and a flame ionization detector as the sensor. In this mode, a fixed volume of sample air is injected (by means of an air injection valve) into the chromatographic column which contains a suitable packing material. At the same time that a sample is introduced into the column, the remaining sample air is directed through an integral charcoal filter (not shown in Figure 1) to provide the detector with a supply of pure air.

While moving through the chromatographic column, the sample constituents are separated based on their interaction with the column packing material. As the constituents leave the column, they are carried to the detector and register on the logarithmic meter and the attached optional chart recorder. The time, measured from

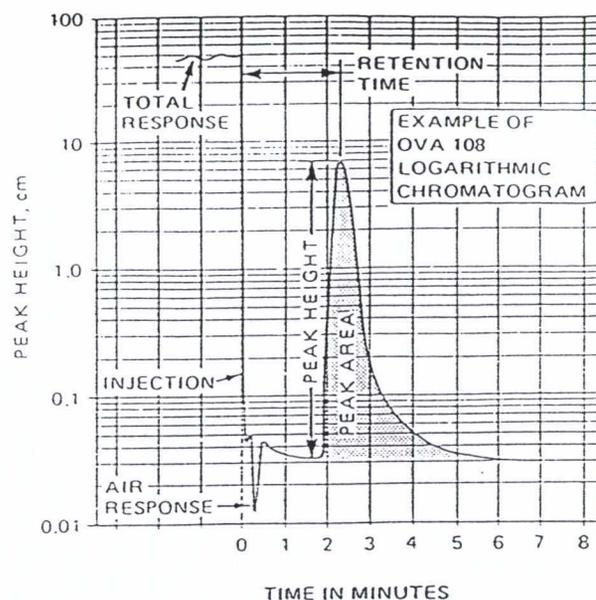


Figure 2. OVA 108 Generalized Chromatogram

the moment of sample injection until the compound of interest exits the column, is known as the retention time and serves to identify the compound. The area under the chromatographic peak is proportional to the concentration of the compound in the air sample. The peak height can also be used to determine sample concentration since it closely correlates with peak area. Figure 2 illustrates an example of a logarithmic chromatogram.

OVA 108 APPLICATIONS

The OVA 108 is well-suited for use in the following typical applications:

- Process Leak Detection in the Petroleum, Chemical, or Natural Gas Industries
- Equipment Leaks of Volatile Organic Carbon (VOC), Reference Methods 18 and 22, Fugitive Emissions, EPA 40, Code of Federal Regulations (CFR), Part 60
- Landfill Monitoring
- Benzene Equipment Leaks, Fugitive Emissions Sources, EPA 40, CFR Part 61
- Equipment Leaks of VOC from Onshore Natural Gas Processing Plants, EPA 40, CFR Part 61
- Stack Monitoring for VOC
- Quality Control Monitoring Carbon Absorption Systems

STANDARD SPECIFICATIONS

Readout 1 to 10 000 ppm, logarithmic scale

Minimum Detectable Limit (Methane) 0.5 ppm

Response Time Approximately two seconds to 90% of reading

Fuel for Detector Hydrogen

Carrier Gas for Chromatograph Hydrogen (self-contained tank)

Sample Flow Rate Approximately 2 L/min

Concentration Alarm Audible alarm, user-selectable level

Electric Power 12 V dc rechargeable battery

Voltage Output to Recorder 0 to 5 V dc

Flame Out Indication Audible and visual

Operation Time in Portable Mode Eight hours

Filters Sintered metal, user-cleanable

Nominal Dimensions (Sidepack)

230 x 300 x 100 mm (9 x 12 x 4 in)

Approximate Mass 5.5 kg (12 lb)

PRODUCT SAFETY SPECIFICATIONS

EPA Reference Method 21

The Environmental Protection Agency, Reference Method 21, EPA 40, CFR Part 60, states the performance specifications by which volatile organic compounds (VOC) will be determined. These performance specifications ensure that instrumentation used to monitor VOC will report the data in a timely, accurate, and safe way. The CENTURY OVA 108 meets the specifications of Method 21 as follows:

1. Flame ionization is an approved detector.
2. The instrument shall be intrinsically safe and meet all aspects of Article 500 of the National Electrical Code of the United States — FM I/1/ABCD.
3. The instrument shall measure the prescribed leak level; example, 10 000 ppm.
4. The sampling rate shall be between 1/2 and 3 litres per minute. The OVA 108 sampling rate is 2 litres per minute.
5. Accuracy shall be $\pm 5\%$ of the designated leak level.
6. Response time must be less than 30 seconds. The OVA 108 has a response time of approximately two seconds.

Electrical Classification

FM certified intrinsically safe for use in Class I, Groups A, B, C, and D, Division 1 hazardous locations.
BASEEFA certified intrinsically safe, Ex ib, for IIC, Zone 1, Temperature Class T6.

INSTRUMENT ACCESSORIES

(Also Refer to Figure Below)

Dilutor Kit Used to monitor inert atmospheres, or extend the concentration range of the instrument. The dilution ratios are adjustable 5 to 50 times. Specify Part Number 511745-1.

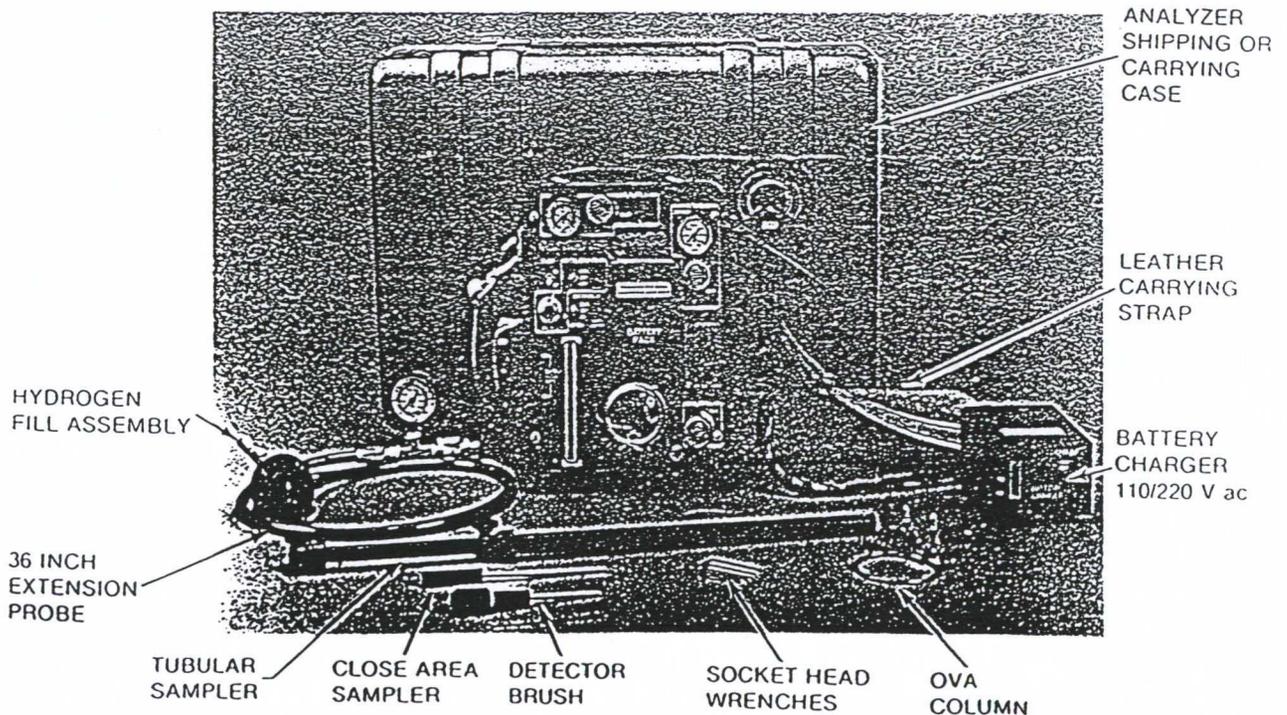
Portable Isothermal Kit (PIP Kit) Used for the temperature control of the OVA columns at 0, 40, and 100°C (32, 104, and 212°F). Specify Part Number 511800-1.

Standard Chromatographic Columns Various column packings available. Specify Part Number 510454, also type and length of column.

Portable Strip Chart Recorder Used for making hard copy records for both Option A and Option B configurations. Specify Part Number 510445-2 for FM certifications, and Part Number 510445-5 for BASEEFA certifications.

Septum Adapter Used for making syringe injections of gases into the instrument. Specify Part Number 510645-1.

Charcoal Filter Adapter Used for zeroing the instrument in contaminated environments. Specify Part Number 510095-1.



INSTRUMENT TYPES

Option A Configured for use as a Survey Mode Analyzer for total hydrocarbon monitoring. Specify OVA 108.

Option B Configured for use as a Survey and Gas Chromatograph Analyzer. Specify OVA 108GC.

ORDERING INSTRUCTIONS

1. Configuration Option A (OVA 108) or Option B (OVA 108GC).
2. Instrument Accessories
3. Electrical Classification
4. Tag and Application

EPA-600/2-81-051

August 1981

PSI-234817

RESPONSE FACTORS OF VOC ANALYZERS
AT A METER READING OF 10,000 PPMV
FOR SELECTED ORGANIC COMPOUNDS

by

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Prepared for

Office of Air Quality Planning and Standards

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SPRINGFIELD, VA 22161

TECHNICAL REPORT DATA

(Please read instructions on the reverse before completing)

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4. TITLE AND SUBTITLE Response Factors of VOC Analyzers at a Meter Reading of 10,000 ppmv for Selected Organic Compounds		8. REPORT DATE March 1981
7. AUTHOR D. A. DuRose and G. E. Harris		9. PERFORMING ORGANIZATION CODE
9. PERFORMING ORGANIZATION NAME AND ADDRESS Radlan Corporation P. O. Box 9948 Austin, Texas 78766		10. PROGRAM ELEMENT NO. 1A5604
12. SPONSORING AGENCY NAME AND ADDRESS EPA, Office of Research and Development Industrial Environmental Research Laboratory Research Triangle Park, NC 27711		11. CONTRACT/GRANT NO. 68-02-3171, Task 28
13. SUPPLEMENTARY NOTES IERL-RTP project officer is Bruce A. Tichenor, Mail Drop 62, 919/541-2547. EPA-600/2-81-002 is a related report.		17. TYPE OF REPORT AND PERIOD COVERED Task Final: 12/80-2/81
14. ABSTRACT The report summarizes results of a reinterpretation of data generated in a laboratory study of the sensitivity of two types of portable hydrocarbon detectors to a variety of organic chemicals. (A previous report, EPA-600/2-81-002, describes and gives original results of the laboratory study.) Detector sensitivity is quantified by a response factor for each chemical where the response factor equals the actual concentration of the chemical divided by the observed concentration from the detector. The previous report estimated response factors at 10,000 ppmv actual concentration of the chemical. This report presents response factors estimated for a 10,000 ppmv detector reading. The instruments were calibrated to 7993 ppmv methane gas.		14. SPONSORING AGENCY CODE EPA/600/13
17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS
Pollution Hydrocarbons Measuring Instruments Sensitivity Organic Compounds		Pollution Control Stationary Sources Hydrocarbon Detectors Response Factors
		c. COSATI Field/Group 13B 07C 14B 14G
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SECTION 1
INTRODUCTION

This technical note summarizes the results of a reinterpretation of the data generated in a laboratory study of the sensitivity of two types of portable hydrocarbon detectors to a variety of organic chemicals. This work is funded by the EPA as part of Contract Number 68-02-3171, Task 28. A previous report (Brown, et al., 1980) presents the description and original results of the laboratory study.

The detector sensitivity is quantified by a "response factor" for each chemical where

$$\text{Response Factor} = \frac{\text{Actual Concentration of Chemical}}{\text{Observed Concentration from Detector}}$$

The previous report (Brown, et al., 1980) estimated response factors of 10,000 ppmv actual concentration of the chemical. This report presents response factors estimated for a 10,000 ppmv detector reading.

The instruments were calibrated to 7993 ppmv methane gas.

SECTION 2
RESULTS

This Technical Note presents response factors for two types of portable hydrocarbon analyzers, the "OVA-103" and the "TLV sniffer", for 168 different chemical compounds. The response factor is defined as the ratio of the actual concentration to the observed concentration (or instrument response).

The response factor varies with concentration. In a previous report (Brown, et al., 1980) the response factors were presented at 10,000 ppmv actual concentration of the chemical.

The response factors are computed at 10,000 ppmv concentration observed by the detector in this Technical Note. Table 2-1 presents response factors for chemicals on both types of instruments along with the 95 percent confidence intervals. The Background Information Document on fugitive emissions from the Synthetic Organic Chemicals Manufacturing Industry (SOCMI) (EPA, 1980) recommends an action level of 10,000 ppmv as read directly on a portable hydrocarbon detector.

Two statistical methods were used here to compute estimates and associated confidence intervals: the classical regression method and the inverse regression method (See Section 3). Both methods of estimation essentially involve the fitting of a line to the actual and instrument observed concentrations. The interpolated or extrapolated actual concentration at 10,000 ppmv observed concentration is calculated based on the fitted line. The response factor is computed as the ratio of this estimated actual concentration to the specified 10,000 ppmv "observed" concentration.

TABLE 2-1

RESPONSE FACTORS
WITH 95 % CONFIDENCE INTERVALS
ESTIMATED AT 10,000 PPMV RESPONSE

COMPOUND ID NO	COMPOUND NAME	VOLATILITY CLASS**	OVA		TLV	
			RESPONSE FACTOR	CONFIDENCE INTERVALS	RESPONSE FACTOR	CONFIDENCE INTERVALS
70	ACETIC ACID	LL	1.04	(1.11, 2.05)	15.00	(7.05, 40.20)
80	ACETIC ANHYDRIDE	LL	1.39	(1.09, 1.88)	0.82 I	(2.71, 12.60)
80	ACETONE	LL	0.80	(0.57, 1.20)	1.22	(0.81, 2.00)
100	ACETONE CYANOHYDRIN	HL	3.51	(0.88, >100.00)	21.00 H	(1.09, >100.00)
110	ACETONITRILE	LL	0.95	(0.85, 1.03)	1.18	(0.94, 1.82)
120	ACETOPHENONE	HL	18.70	(5.52, >100.00)		
125	ACETYL CHLORIDE	LL	2.04	(1.72, 2.48)	2.72	(1.05, 8.22)
130	ACETYLENE	G	0.30	(0.30, 0.43)		
160	ACRYLIC ACID	LL	4.59	(3.30, 8.57)		
170	ACRYLONITRILE	LL	0.27	(0.80, 1.20)	3.49 I	(0.44, 27.80)
	ALLENE	G	0.04	(0.00, 0.89)	15.00	(0.05, 20.60)
200	ALLYL ALCOHOL	LL	0.98	(0.70, 1.27)		
250	AMYL ALCOHOL, N-	HL	0.75	(0.57, 1.04)	2.14	(0.45, >100.00)
2655	AMYLENE	LL	0.44	(0.34, 0.81)	1.03	(0.50, 2.59)
320	ANISOLE	LL	0.92	(0.85, 1.48)	3.91	(0.52, >100.00)
380	BENZALDEHYDE	HL	2.40	(1.38, 5.82)		
380	BENZENE	LL	0.29	(0.28, 0.31)	1.07	(0.20, 1.20)
450	BENZONITRILE	HL	2.89	(1.18, 15.30)		
490	BENZOYL CHLORIDE	HL	22.10 D	(3.43, >100.00)		
530	BENZYL CHLORIDE	HL	15.30 D	(3.86, >100.00)		
570	BROMOBENZENE	LL	0.40	(0.34, 0.48)	1.19	(0.27, >100.00)
590	BUTADIENE, 1,3-	G	0.57	(0.94, 0.80)	10.80	(8.11, 15.40)
	BUTANE, N-	G	0.50	(0.48, 0.55)	0.83	(0.53, 0.70)
640	BUTANOL, N	LL	1.44 I	(0.89, 2.34)	4.11 I	(2.10, 7.83)
650	BUTANOL, SEC-	LL	0.70	(0.70, 0.83)	1.25	(0.98, 1.83)
660	BUTANOL, TERT	S	0.53	(0.38, 0.81)	2.17	(1.34, 4.43)

* ORGANIC CHEMICAL PRODUCERS DATA BASE
** G-GAS; LL-LIGHT LIQUID; HL-HEAVY LIQUID.

DEFINITION OF EXPLANATORY DATA CODES:

I INVERSE ESTIMATION METHOD X NO DATA AVAILABLE
O POSSIBLE OUTLIERS IN DATA B 10,000 PPMV RESPONSE UNACHIEVABLE
H NARROW RANGE OF DATA P SUSPECT POINTS ELIMINATED

TABLE 2-1 (Continued)

RESPONSE FACTORS
WITH 95 % CONFIDENCE INTERVALS
ESTIMATED AT 10,000 PPMV RESPONSE

OCPOB: 10 NO	COMPOUND NAME	VOLATILITY CLASS**	OVA		TLV	
			RESPONSE FACTOR	CONFIDENCE INTERVALS	RESPONSE FACTOR	CONFIDENCE INTERVALS
592	BUTENE, 1-	G	0.58	(0.51, 0.62)	5.84	(4.20, 8.89)
600	BUTYL ACETATE,	LL	0.80	(0.54, 0.83)	1.30	(1.15, 1.70)
630	BUTYL ACRYLATE, N-	LL	0.70	(0.03, 0.74)	2.67 I	(1.17, 5.63)
	BUTYL ETHER, N	LL	2.00	(0.81, 05.00)	3.54 I	(1.82, 7.04)
	BUTYL ETHER, SEC	LL	0.35	(0.21, 0.85)	1.15	(0.78, 2.17)
870	BUTYLAMINE, N-	LL	0.89	(0.53, 0.98)	2.02	(1.14, 4.87)
880	BUTYLAMINE, SEC-	LL	0.70	(0.58, 0.87)	1.50	(0.77, 5.24)
890	BUTYLAMINE, TERT-	LL	0.67	(0.58, 0.70)	1.95	(1.42, 2.81)
	BUTYLBENZENE, TERT-	HL	1.32	(0.89, 2.20)		
750	BUTYRALDEHYDE H-	LL	1.29	(1.07, 1.31)	2.30	(0.80, 12.80)
700	BUTYRIC ACID	HL	0.80	(0.38, 3.14)	10.70 I	(0.53, 17.80)
780	BUTYRONITRILE	LL	0.52	(0.40, 0.74)	1.47 I	(0.82, 3.48)
790	CARBON DISULFIDE	LL			3.02	(1.87, 12.80)
830	CHLOROACETALDEHYDE	LL	3.10	(5.73, 10.20)	5.07	(3.00, 9.79)
890	CHLOROBENZENE	LL	0.38	(0.32, 0.47)	0.88	(0.77, 1.00)
1740	CHLOROETHANE	G	5.30 I	(1.87, 28.40)	3.90 P	(1.58, 14.10)
930	CHLOROFORM	LL	9.28	(5.19, 20.00)		
900	CHLOROPHENOL, O-	HL	4.50	(1.72, 27.20)	18.00 I	(8.50, 51.50)
	CHLOROPROPENE, 1-	LL	0.87	(0.81, 0.73)	0.87	(0.69, 1.10)
210	CHLOROPROPENE, 3-	LL	0.80	(0.72, 0.90)	1.24	(1.08, 1.42)
870	CHLOROTOLUENE, M-	LL	0.48	(0.45, 0.51)	0.91	(0.40, 7.47)
980	CHLOROTOLUENE, O-	LL	0.48	(0.42, 0.55)	1.00	(0.33, >100.00)
990	CHLOROTOLUENE, P-	LL	0.58	(0.52, 0.61)	1.17 I	(0.77, 1.77)
1010	CRESOL, O-	S	0.80	(0.70, 1.45)	4.30 I	(0.40, 47.40)
1040	CROTONALDEHYDE	LL	1.25	(0.82, 2.24)		

* ORGANIC CHEMICAL PRODUCERS DATA BASE
** G=GAS; LL=LIGHT LIQUID; HL=HEAVY LIQUID.

DEFINITION OF EXPLANATORY DATA CODES:

I INVERSE ESTIMATION METHOD	X NO DATA AVAILABLE
D POSSIBLE OUTLIERS IN DATA	B 10,000 PPMV RESPONSE UNACHIEVABLE
N NARROW RANGE OF DATA	P SUSPECT POINTS ELIMINATED

TABLE 2-1 (Continued)

RESPONSE FACTORS
WITH 95 % CONFIDENCE INTERVALS
ESTIMATED AT 10,000 PPMV RESPONSE

OCFDD ID NO	COMPOUND NAME	VOLATILITY CLASS**	UVA		TLV	
			RESPONSE FACTOR	CONFIDENCE INTERVALS	RESPONSE FACTOR	CONFIDENCE INTERVALS
1000	CUMENE	LL	1.87	(1.10, 3.71)		
1120	CYCLOHEXANE	LL	0.47	(0.33, 0.58)	0.70	(0.62, 0.80)
1130	CYCLOHEXANOL	HL	0.85	(0.65, 1.20)		
1140	CYCLOHEXANONE	LL	1.50	(0.97, 2.70)	7.04	(1.89, >100.00)
1150	CYCLOHEXENE	LL	0.49	(0.42, 0.57)	2.17	(1.79, 2.74)
1100	CYCLOHEXYLAMINE	LL	0.57	(0.42, 0.88)	1.38	(1.28, 1.48)
	DECANE	HL	0.09 N	(0.05, >100.00)	0.10	(0.07, 0.25)
1190	DIACETONE ALCOHOL	HL	1.45	(0.90, 2.48)	0.98	(0.44, 5.93)
	DIACETYL	LL	1.54	(1.25, 1.92)	3.28	(2.25, 5.12)
1270	DICHLORO-1-PROPENE, 2,3-	LL	0.75	(0.58, 1.09)	1.75	(1.14, 3.18)
1215	DICHLOROBENZENE, M-	HL	0.84	(0.55, 0.77)	2.30	(0.58, >100.00)
1210	DICHLOROBENZENE, O-	HL	0.68	(0.47, 1.11)	1.26	(0.35, >100.00)
	DICHLOROETHANE, 1,1-	LL	0.78	(0.62, 1.02)	1.88	(1.58, 2.28)
1244	DICHLOROETHANE, 1,2-	LL	0.95	(0.77, 1.22)	2.15	(1.03, 2.82)
1235	DICHLOROETHYLENE, CIS 1,2-	LL	1.27	(1.05, 1.50)	1.03	(0.89, 3.47)
1230	DICHLOROETHYLENE, TRANS 1,2-	LL	1.11	(0.88, 1.27)	1.04	(0.67, 12.60)
2020	DICHLOROMETHANE	LL	2.81	(2.13, 3.87)	3.85	(2.40, 6.84)
3110	DICHLOROPROPANE, 1,2-	LL	1.03	(0.82, 1.30)	1.05	(1.00, 3.05)
1440	DIIISOBUTYLENE	LL	0.35	(0.29, 0.44)	1.41	(0.90, 2.40)
1670	DIMETHOXY ETHANE, 1,2-	LL	1.22	(0.84, 3.01)	1.52	(0.83, 8.38)
1490	DIMETHYLFORMAMIDE, N,N-	LL	4.10	(2.90, 6.58)	5.28	(4.05, 7.20)
1485	DIMETHYLHYDRAZINE 1,1-	LL	1.03	(0.77, 1.45)	2.70	(0.51, >100.00)
1520	DIMETHYLSULFOXIDE	HL	0.07	(0.05, 0.11)	8.45	(4.15, 17.20)
1480	DIOXANE	LL	1.48	(1.04, 2.33)	1.31	(0.70, 3.00)
1080	EPICHLOROHYDRIN	LL	1.69	(1.58, 1.84)	2.03	(1.79, 2.33)

* ORGANIC CHEMICAL PRODUCERS DATA BASE
** G=GAS; LL=LIGHT LIQUID; HL=HEAVY LIQUID.

DEFINITION OF EXPLANATORY DATA CODES:

I	INVERSE ESTIMATION METHOD	X	NO DATA AVAILABLE
O	POSSIBLE OUTLIERS IN DATA	B	10,000 PPMV RESPONSE UNACHIEVABLE
N	NARROW RANGE OF DATA	P	SUSPECT POINTS ELIMINATED

TABLE 2-1 (Continued)

RESPONSE FACTORS
WITH 95 % CONFIDENCE INTERVALS
ESTIMATED AT 10,000 PPMV RESPONSE

CCPDB ID NO	COMPOUND NAME	VOLATILITY CLASS**	OVA		TLV	
			RESPONSE FACTOR	CONFIDENCE INTERVALS	RESPONSE FACTOR	CONFIDENCE INTERVALS
		G	0.85	(0.44, 1.58)	0.09 I	(0.21, 2.39)
	ETHANE	LL	1.78	(1.50, 2.01)	X	
1000	ETHANOL	LL	1.55	(1.20, 1.88)	1.82	(0.80, 5.12)
1010	ETHOXY ETHANOL, 2-	LL	0.86	(0.77, 0.85)	1.43	(1.07, 2.00)
1070	ETHYL ACETATE	HL	3.82	(1.89, 10.70)	5.60	(1.83, 32.80)
1080	ETHYL ACETOACETATE	LL	0.77	(0.83, 0.97)	X	
1090	ETHYL ACRYLATE	LL	1.99	(1.70, 2.38)	1.59	(0.40, >100.00)
1750	ETHYL CHLOROACETATE	LL	0.97	(0.77, 1.30)	1.14	(0.24, 1.42)
1990	ETHYL ETHER	LL	0.73	(0.62, 1.11)	4.74 D	(1.38, 81.20)
1710	ETHYLBENZENE	LL	0.71	(0.83, 0.82)	1.50	(1.20, 2.00)
1770	ETHYLENE	G	2.46	(1.85, 3.29)	2.40	(0.86, >100.00)
1980	ETHYLENE OXIDE	LL	1.73	(1.29, 2.48)	3.28	(0.74, >100.00)
1800	ETHYLENEDIAMINE	LL	14.20	(10.60, 19.80)	B	
2080	FORMIC ACID	LL	8.88	(3.33, 19.70)	5.60	(2.04, 34.70)
2105	GLYCIDOL	LL	0.41 I	(0.28, 0.00)	0.73	(0.33, 8.10)
	HEPTANE	LL	0.41	(0.38, 0.45)	0.08	(0.63, 0.78)
	HEXANE, N-	LL	0.49	(0.39, 0.68)	4.69 D	(0.85, >100.00)
	HEXENE, 1-	LL	0.90	(4.45, 12.10)	15.20	(8.11, 80.40)
	HYDROXYACETONE	G	0.41	(0.29, 1.04)	0.55	(0.41, 0.81)
	ISOBUTANE	G	3.13	(0.90, 38.50)	B	
2200	ISOBUTYLENE	LL	0.59	(0.48, 0.80)	X	
2350	ISOPRENE	LL	0.91	(0.72, 1.20)	1.39	(0.04, 2.31)
2300	ISOPROPANOL	LL	0.71	(0.82, 0.83)	1.31	(1.04, 1.72)
2370	ISOPROPYL ACETATE	LL	0.68	(0.00, 0.77)	0.98	(0.82, 1.22)
2300	ISOPROPYL CHLORIDE	LL	0.68	(0.00, 0.77)	2.19 D	(1.14, 8.65)
	ISOVALERALDEHYDE	LL	0.84	(0.57, 0.74)		

* ORGANIC CHEMICAL PRODUCERS' DATA BASE
** G-GAS; LL-LIGHT LIQUID; HL-HEAVY LIQUID.

DEFINITION OF EXPLANATORY DATA CODES:

I INVERSE ESTIMATION METHOD X NO DATA AVAILABLE
D POSSIBLE OUTLIERS IN DATA B 10,000 PPMV RESPONSE UNACHIEVABLE
H NARROW RANGE OF DATA P SUSPECT POINTS ELIMINATED

TABLE 2-1 (Continued)

RESPONSE FACTORS
WITH 95 % CONFIDENCE INTERVALS
ESTIMATED AT 10,000 PPMV RESPONSE

UCPDB* ID NO	COMPOUND NAME	VOLATILITY CLASS**	OVA		TLV	
			RESPONSE FACTOR	CONFIDENCE INTERVALS	RESPONSE FACTOR	CONFIDENCE INTERVALS
2460	MESITYL OXIDE	LL	1.09	(0.94, 1.24)	3.14	(1.43, 12.00)
	METHACROLEIN	LL	1.20	(0.92, 1.71)	3.42 D	(1.51, 18.80)
2480	METHACRYLIC ACID	HL	0.82	(0.31, 14.70)	1.00 I	(0.24, 4.54)
2500	METHANOL	LL	4.38 P	(3.61, 5.00)	2.01	(1.06, 2.44)
1930	METHOXY-ETHANOL, 2-	LL	2.25	(1.02, 3.34)	3.13	(1.12, 27.40)
2510	METHYL ACETATE	LL	1.74	(1.40, 2.13)	1.85	(1.44, 2.49)
	METHYL ACETYLENE	G	0.01	(0.50, 0.04)	0.79	(4.80, 10.40)
2500	METHYL CHLORIDE	G	1.44	(1.22, 1.70)	1.84	(0.73, >100.00)
2040	METHYL ETHYL KETONE	LL	0.84	(0.51, 0.84)	1.12	(0.93, 1.24)
2645	METHYL FORMATE	LL	3.11	(2.42, 4.14)	1.94	(1.72, 2.21)
2005	METHYL METHACRYLATE	LL	0.99	(0.90, 1.10)	2.42	(1.39, 5.26)
2050	METHYL-2-PENTANOL, 4-	LL	1.08	(1.27, 2.32)	2.00	(1.40, 3.18)
2080	METHYL-2-PENTANONE, 4-	LL	0.50	(0.46, 0.09)	1.03	(1.22, 2.26)
2550	METHYL-3-BUTYL-2-OL, 2	LL	0.59	(0.44, 0.80)	X	
	METHYLAL	LL	1.37	(1.00, 1.83)	1.49	(1.24, 1.74)
2540	METHYLANILINE, N-	HL	4.04	(3.81, 5.57)	8.40 ?	(2.55, 25.20)
2570	METHYLCYCLOHEXANE	LL	0.48	(0.20, 1.39)	0.84	(0.88, 1.09)
	METHYLCYCLOHEXENE, 1-	LL	0.44	(0.30, 0.54)	2.79	(1.79, 5.12)
2070	METHYLPENTYOL	LL	1.17	(0.71, 2.48)	3.42	(1.83, 8.54)
2690	METHYLSTYRENE, A-	LL	13.90	(9.50, 21.50)	B	
2700	MORPHOLINE	LL	0.92	(0.87, 1.40)	2.59 I	(0.64, 10.50)
2770	NITROBENZENE	HL			0.01 I	(0.00, 12.80)
2790	NITROETHANE	LL	1.40	(1.20, 1.83)	3.45	(1.50, 13.00)
2791	NITROETHANE	LI	3.52	(3.03, 4.15)	7.00	(1.91, >100.00)
2795	NITROPROPANE	LL	1.05	(0.80, 1.48)	2.02	(1.17, 4.47)

* ORGANIC CHEMICAL PRODUCERS DATA BASE

** G=GAS; LL=LIGHT LIQUID; HL=HEAVY LIQUID.

DEFINITION OF EXPLANATORY DATA CODES:

I INVERSE ESTIMATION METHOD
D POSSIBLE OUTLIERS IN DATA
N NARROW RANGE OF DATA

X NO DATA AVAILABLE
B 10,000 PPMV RESPONSE UNACHIEVABLE
P SUSPECT POINTS ELIMINATED

TABLE 2-1 (Continued)

RESPONSE FACTORS
WITH 95 % CONFIDENCE INTERVALS
ESTIMATED AT 10,000 PPMV RESPONSE

OCPOB ID NO	COMPOUND NAME	VOLATILITY CLASS**	OVA		TLY	
			RESPONSE FACTOR	CONFIDENCE INTERVALS	RESPONSE FACTOR	CONFIDENCE INTERVALS
	NONANE-N	LL	1.54	(0.94, 2.88)	11.10	(3.13, >100.00)
	OCTANE	LL	1.03	(0.69, 1.21)	2.11	(1.64, 2.75)
2851	PENTANE	LL	0.52	(0.42, 0.60)	0.62	(0.67, 0.70)
2973	PICOLINE, 2-	LL	0.43	(0.38, 0.50)	1.18	(1.00, 1.28)
	PROPANE	Q	0.85 I	(0.46, 0.72)	0.60 P	(0.59, 0.69)
3003	PROPIONALDEHYDE	LL	1.14	(1.00, 1.32)	1.71	(1.11, 3.00)
3030	PROPIONIC ACID	LL	1.00	(1.03, 1.70)	5.04 D	(0.72, >100.00)
3070	PROPYL ALCOHOL	LL	0.83	(0.77, 1.10)	1.74	(1.00, 3.80)
	PROPYLBENZENE, N-	LL	0.51	(0.45, 0.58)	B	
3090	PROPYLENE	Q	0.77	(0.44, 2.00)	1.74 I	(0.10, 20.30)
3120	PROPYLENE OXIDE	LL	0.83	(0.74, 0.95)	1.15	(0.80, 2.48)
3130	PYRIDINE	LL	0.47	(0.40, 0.55)	1.10	(1.03, 1.34)
3230	STYRENE	LL	4.22	(3.45, 8.27)	B	
3200	TETRACHLOROETHANE, 1, 1, 1, 2	LL	4.83 D	(1.24, >100.00)	0.91	(3.14, 22.80)
3291	TETRACHLOROETHANE, 1, 1, 2, 2	LL	7.89	(5.01, 13.80)	25.40	(8.06, >100.00)
3000	TETRACHLOROETHYLENE	LL	2.97	(1.71, 0.11)	B	
3348	TOLUENE	LL	0.39	(0.38, 0.43)	2.08 D	(0.79, >100.00)
3393	TRICHLOROETHANE, 1, 2, 4-	HL	1.21 I	(0.50, 2.94)	0.47 I	(0.32, 0.68)
3393	TRICHLOROETHANE, 1, 1, 1-	LL	0.80	(0.72, 0.90)	2.40	(1.01, 3.35)
3400	TRICHLOROETHANE, 1, 1, 2-	LL	1.25	(1.05, 1.50)	3.09	(2.77, 8.16)
3410	TRICHLOROETHYLENE	LL	0.95	(0.83, 1.09)	3.93	(2.81, 0.32)
3420	TRICHLOROPROPANE, 1, 2, 3-	LL	0.98	(0.64, 1.78)	1.99	(1.27, 3.82)
3450	TRIETHYLAMINE	LL	0.51	(0.40, 0.70)	1.48	(0.90, 2.78)
3510	VINYL ACETATE	LL	1.27	(0.95, 1.82)	5.91 D	(1.20, >100.00)
3520	VINYL CHLORIDE	Q	0.84	(0.61, 1.38)	1.03	(0.50, 4.60)

* ORGANIC CHEMICAL PRODUCERS DATA BASE
** Q-GAS; LL-LIGHT LIQUID; HL-HEAVY LIQUID.

DEFINITION OF EXPLANATORY DATA CODES:

I INVERSE ESTIMATION METHOD	X NO DATA AVAILABLE
O POSSIBLE OUTLIERS IN DATA	B 10,000 PPMV RESPONSE UNACHIEVABLE
H NARROW RANGE OF DATA	P SUSPECT POINTS ELIMINATED

TABLE 2-1 (Continued)

RESPONSE FACTORS
WITH 90 % CONFIDENCE INTERVALS
ESTIMATED AT 10,000 PPMV RESPONSE

OCPDG ID NO	COMPOUND NAME	VOLATILITY CLASS**	OVA		TLV	
			RESPONSE FACTOR	CONFIDENCE INTERVALS	RESPONSE FACTOR	CONFIDENCE INTERVALS
	VINYL PROPIONATE	LL	1.00 I (	0.87, 1.74)	1.21 I (	0.40, 3.20)
3930	VINYLDENE CHLORIDE	LL	1.12 (	0.87, 1.52)	2.41 (	1.82, 3.73)
3970	XYLENE, P-	LL	2.12 (	1.71, 2.08)	7.07 (	3.49, 24.80)
3950	XYLENE, H-	LL	0.40 (	0.38, 0.46)	5.87 D (	0.91, >100.00)
3900	XYLENE, O-	LL	0.43 (	0.28, 0.85)	1.40 (	0.61, 3.33)

* ORGANIC CHEMICAL PRODUCERS DATA BASE
** G-GAS; LL-LIGHT LIQUID; HL-HEAVY LIQUID.

DEFINITION OF EXPLANATORY DATA CODES:

I	INVERSE ESTIMATION METHOD	X	NO DATA AVAILABLE
D	POSSIBLE OUTLIERS IN DATA	3	10,000 PPMV RESPONSE UNACHIEVABLE
N	NARROW RANGE OF DATA	^	SUSPECT POINTS ELIMINATED

Most of the response factors and associated confidence intervals were calculated using the classical method; those computed using the inverse method are noted in Table 2-1 with the explanatory code "I". Other explanatory codes used in Table 2-1 indicate data availability, data applicability and possible data uncertainties such as the presence of outliers.

In most cases the data fell very nearly on a straight line, but sometimes they did not. When outliers were clearly defined they were removed from the data and the response factor recomputed. This could not always be done. Often it was not clear which data points were valid and which were not. Additional data would be necessary to clarify these situations. Since it was not clear which points should be removed in these cases, all points were included.

Table 2-2 lists chemicals tested which do not appear to respond at a 10,000 ppmv reading at any concentration. The data and the fitted line showed that the response appears to be well below 10,000 ppmv for feasible actual concentrations. Sometimes it was not possible to distinguish between this situation and the problem of unresolved outliers mentioned above. Questionable or borderline cases are included in Table 2-1 rather than Table 2-2. Some of these chemicals have large estimated response factors and wide confidence intervals.

TABLE 2-2. A LIST OF TESTED CHEMICALS WHICH APPEAR TO BE UNABLE TO ACHIEVE AN INSTRUMENT RESPONSE OF 10,000 PPMV AT ANY FEASIBLE CONCENTRATION

OVA		TLV	
OCPDB*	Compound Name	OCPDB	Compound Name
-	Acetyl-1-propanol, 3-	120	Acetophenone
790	Carbon disulfide	-	Acetyl-1-propanol, 3-
810	Carbon tetrachloride	130	Acetylene
-	Dichloro-1-propanol, 2,3-	160	Acrylic Acid
-	Dichloro-2-propanol, 1,3-	360	Benzaldehyde
-	Diisopropyl benzene, 1,3-	450	Benzonitrile
-	Dimethylstyrene, 2,4	490	Benzoyl chloride
1221	Freon 12	530	Benzyl chloride
2073	Furfural	-	Butylbenzene, tert-
-	Methyl-2,4-Pentanediol, 2-	810	Carbon tetrachloride
1660	Monoethanolamine	930	Chloroform
2770	Nitrobenzene	1040	Crotonaldehyde
2910	Phenol	1060	Cumene
-	Phenyl-2-Propanol, 2-	1130	Cyclohexanol
		-	Dichloro-1-propanol, 2,3-
		-	Dichloro-2-propanol, 1,3-
		-	Diisopropyl benzene, 1,3-
		-	Dimethylstyrene, 2,4-
		2060	Formic acid
		1221	Freon 12
		2073	Furfural
		2200	Isobutylene
		-	Methyl-2,4-pentanediol
		2690	Methylstyrene, A-
		1660	Monoethanolamine
		2910	Phenol
		-	Phenyl-2-propanol, 2-
		-	Propylbenzene, N-
		3230	Styrene
		2860	Tetrachloroethylene

*Organic Chemical Producers Data Base ID Number

SECTION 3
DATA ANALYSIS

The estimated response factors at 10,000 ppmv for the OVA and TLV were calculated as follows: A classical least squares line was fitted to the actual concentrations and instrument response readings on a logarithmic scale. The logarithm of the actual concentration at response log 10,000 was then computed by solving the equation using the fitted parameters. The result was then transformed to the data scale and divided by 10,000 to yield the desired response factor. A 95 percent confidence interval was computed following Brownlee (1965). The results are presented in Table 2-1.

In some cases Brownlee's (1965) confidence interval gives indeterminate values. This generally is due to a regression line that is flat relative to the observed error or to other data problems. Response factors estimated by an inverse regression were generally agreeable to the method described above. In those cases where the confidence interval was indeterminate, the inverse regression estimate and confidence interval were computed as an alternate. These inverse estimates are indicated in Table 2-1 by an explanatory code "I".

3.1 Classical Estimation of Response Factors

Let c_i be the actual concentration of the selected chemical and r_i be the corresponding instrument response for $i = 1, \dots, n$ observations. Consider then the transformed variates

$$y_i = \ln r_i$$

$$x_i = \ln c_i$$

and the relationship

$$y_i = \alpha + \beta x_i + e_i \quad (1)$$

where e_i is a random error of measurement. Let a and b be the classical least squares estimates of α and β , respectively.

Now, suppose that at some unknown x_0

$$\ln 10,000 = \alpha + \beta x_0$$

Then estimate x_0 by

$$\hat{x}_{01} = (\ln 10,000 - a)/b$$

and estimate the actual concentration corresponding to 10,000 ppmv observed instrument response by

$$\hat{c}_{01} = \exp(\hat{x}_{01}).$$

A confidence interval based on classical least squares estimation is derived by Brownlee (1965):

$$CL_k = \bar{x} + \frac{b(\hat{c}_k - a)}{b^2 - \tau_k^2 s^2 / \sum (x_i - \bar{x})^2} - \frac{\tau_k^2 s}{b^2 - \tau_k^2 s^2 / \sum (x_i - \bar{x})^2} \\ \times \left\{ \left[b^2 - \frac{\tau_k^2 s}{\sum (x_i - \bar{x})^2} \right] \left(\frac{1}{n} \right) \div \frac{(\hat{c}_k - a)^2}{\sum (x_i - \bar{x})^2} \right\}^{\frac{1}{2}}$$

where $k = 1, 2$

$t_1 = +t$ and $t_2 = -t$, with t being the tabular value for 95 percent confidence from student's t -distribution with $n-2$ degrees of freedom.

$s^2 = E(y_i - \hat{y}_i)/(n-2)$, with $\hat{y}_i = a + bx_i$, and

$\phi = \ln 10,000$ (in Brownlee, this is the mean of m observed responses. Here, the desired response is exact, so $m = \infty$ and $1/m = 0$).

The value CL_2 provides the lower limit and CL_1 provides the upper limit. These limits were computed in the logarithmic scale and then exponentiated into the data scale.

3.2 Inverse Estimation of Response Factors

Let x_i and y_i be as described above except that the inverse model relationship

$$x_i = \delta + \gamma y_i + \epsilon_i \quad (2)$$

is fitted by least squares. Let d and g be the estimates of δ and γ , respectively. Then if

$$x_0 = \delta + \gamma \ln 10,000$$

estimate x_0 by

$$\hat{x}_{02} = d + g \cdot \ln 10,000.$$

Assuming normality of the errors ϵ_i ,

$$\hat{c}_{02} = \exp(\hat{x}_{02} + \frac{s^2}{2}) \quad (3)$$

is an approximately unbiased estimate of

$$c_0 = \exp(x_0)$$

where s^2 is the estimated variance of the ϵ_i .

A confidence interval for x_0 can be computed by the usual method:

$$\hat{x}_{02} \pm ts \sqrt{\frac{1}{n} + (x_0 - \bar{x})^2 / \sum (x_i - \bar{x})^2}$$

where t is the 95 percent confidence level tabular value from Student's t -distribution with $n-2$ degrees of freedom. The confidence limits for \hat{c}_{02} are computed by applying the transformation of (3) to these limits for x_0 .

3.3 Discussion

Both of the models (1) and (2) cannot be correct simultaneously. If the model (2) is correct for the data, then the second or inverse approach is appropriate. However, if the model (1) is correct, then both approaches produce biased estimates. Generally speaking, the bias of the classical method will be smaller since it is a consistent estimator (bias reduces to zero as sample size increases without bound). The variance, however, may tend to be larger.

The model (1) appears to best approximate the data collected for this study. The classical approach was used as the primary method in this report.

because of its consistency and reputed superiority in extrapolation. The properties of the data for most of the chemicals are such that the two approaches are virtually equivalent. A comparison of computed values confirmed this hypothesis.

SECTION 4
LITERATURE REVIEW

The statistical literature is clear on how to estimate y for a given x when y and x are related by

$$y = \alpha + \beta x$$

and y is subject to error. There has been much disagreement on how to estimate an unknown x given an observed value of y in the same situation. For many years it was universally assumed that the unknown x should be solved for using the usual parameter estimates. Some have suggested that the parameters be fitted by an inverse "x on y" regression and the unknown x estimated directly. There has been considerable controversy over this and some classic assumptions have proven unfounded.

The properties of the two estimates are summarized in the following table:

Property	Classic (y on x)	Inverse (x on y)
Bias	Biased	Biased
Asymptotic Bias	Consistent	Inconsistent
Variance		
--Under Normality	Infinite	Finite
--Truncated Normality	Large but Finite	Finite
Quality as Estimator	Both good and equivalent	
--Well determined line		
--Interpolation with ill determined line	Poor	Good
--Extrapolation	Good	Poor

In this study, many of the needed estimates are extrapolations just beyond the end of the available data. Many of the lines are fairly well determined. Thus, it is not completely clear which estimate is truly best here, but they are likely to be nearly equivalent. For this study, the classic estimator is used except in cases where it is clearly not appropriate. The inverse estimator is used for these cases.

The following is a summary of the literature examined on this subject:

The relationship between two variables y and x can often be expressed as a simple linear function. If the variable x takes on fixed values x_i for which responses y_i are measured, the relationship is usually expressed as the linear regression model

$$y_i = \alpha + \beta x_i + e_i \quad i = 1, \dots, n \quad (1)$$

where the e_i are random errors and n is the number of observed pairs (x_i, y_i) . It is usually assumed that the e_i are independent and identically distributed, and furthermore, that they are distributed according to a normal distribution with mean 0 and variance σ^2 .

It is well known that the usual least squares estimates of α and β in (1) are Best Linear Unbiased Estimators (BLUE), where "best" means "smallest variance". Estimates of $y_i = \alpha + \beta x_i$ based on the least squares estimates of α and β are also BLUE. Under the assumption of normality of errors, these estimates are also maximum likelihood estimates. The least squares estimators have many other useful and beneficial properties.

Here we must consider a slightly different problem known as the Calibration Problem. In addition to the responses y_i on known x_i , there are further responses z_j corresponding to an unknown x_0 . The extended

model is

$$y_i = \alpha + \beta x_i + e_i \quad i = 1, \dots, n \quad (2)$$

$$z_j = \alpha + \beta x_0 + e_j \quad j = 1, \dots, m \quad (3)$$

The problem here is to provide point and interval estimates for x_0 rather than to estimate y_i, α , or β .

The above discussion closely follows Kalotay (1971).

At least since Eisenhart (1939) the accepted solution has been to estimate the unknown x_0 by inverting the least squares estimates from (2):

$$\hat{x}_{0_1} = \frac{\bar{z} - a}{b}$$

where \bar{z} is the mean of the z_j in (3) and a and b are the least squares estimates of α and β respectively. This is referred to as the "classical" estimator.

Krutchkoff (1967, 1969) challenged this approach by claiming that a superior estimate could be had by inverting the regression variables; that is, compute the least squares estimates of $\hat{\delta}$ and $\hat{\gamma}$ from the model

$$x_i = \hat{\delta} + \hat{\gamma} y_i + \epsilon_i$$

and estimating the unknown x_0 directly by

$$\hat{x}_{0_2} = \hat{d} + \hat{g} \bar{z}$$

where d and g are the least squares estimates of δ and γ respectively.

This is referred to as the "inverse" estimator. Krutchkoff based his assertion not on mathematical statistical properties but on Monte Carlo simulations.

After Krutchkoff's results appeared there was a flurry of reaction. Williams (1969) reported that if normality of errors was assumed, then the classical estimator \hat{x}_{01} has infinite variance. He showed further that no unbiased estimate of x_0 would have finite variance under this condition and that the inverse estimator \hat{x}_{02} is biased. On this basis he recommends the classical estimator.

Berkson (1969) showed that the inverse estimator \hat{x}_{02} has a smaller Mean Square Error (MSE) than the classical estimator \hat{x}_{01} when x_0 is in the neighborhood of \bar{x} , the mean of the x_1 's. However, if x_0 is not near \bar{x} then the classical estimator has lower MSE. Furthermore, the inverse estimator is not only biased for finite n but is inconsistent: The bias does not reduce to zero as n increases without bound. On this basis he also recommends the classical estimator. Martinelle (1970), looking at relative efficiency, agrees with Berkson. Saw (1970) agrees with Martinelle on the same basis.

Hoadly (1970) reaffirms that the classical estimator has infinite variance if normality is assumed. It may also have infinite confidence intervals. He then proposes an alternative solution based on Bayesian methods.

Williams (1969) had suggested that an MSE comparison was inappropriate since under normality the classical estimator always has infinite MSE so any finite MSE estimate could beat it, including any constant value. To avoid this Halperin (1970) compares the two approaches based on Pitman's closeness criterion. He showed that the inverse estimator was superior in the neighborhood of \bar{x} . However, he believes that the neighborhood where the inverse estimator is superior is too small to recommend it over the

classical estimator.

Krutchkoff (1970, 1971, 1972) defended his point of view primarily with Monte Carlo simulations. His results indicate that the inverse estimator is better by the closeness criterion when x_0 is near \bar{x} . The classical estimator is better further out from \bar{x} .

Kalotay (1971), recognizing that the classical estimator has certain unsatisfactory properties, proposes an alternative estimator which he compares to Hoadley's (1970) Bayesian estimator. Kalotay's structural solution to the problem is not practical for any but very small sample sizes. He points out that under certain conditions his estimator reduces to the inverse estimator.

Shukla (1972) developed approximate formulas for bias, variance, and MSE of both classical and inverse estimators. He shows that both are biased but that the classical estimator is asymptotically unbiased, unlike the inverse estimator. However, both biases reduce to zero when the unknown x_0 is at the mean of the x_1 . Using the optimal design for the classical estimator, the inverse estimator has smaller MSE than the classical estimator in the range of the x_1 . Nevertheless, Shukla (1972) recommends the classical estimator for its bias properties.

Earlier critics of the inverse estimator rejected it because it is not only biased but inconsistent. The classical estimates for α , β , and y_1 are unbiased but it was not proven that the classical estimator \hat{x}_{01} is unbiased for x_0 . Naszodi (1978) shows that the classical estimator is also biased. Furthermore, if normality is assumed, it has no expectation.

Naszodi (1978) points out that in practical problems, perfect normality rarely exists. In fact, even when data errors are normal, extreme values will generally be discarded. Thus, in reality the distribution is a truncated normal. In any case, Naszodi (1978) gives a new estimator

involving an approximate bias correction for the classical estimator. Based on a simulation, all three estimators appear to have about the same MSE with the inverse estimator having the lowest and the classical the highest.

Brown (1979) points out that the objectives of the estimation in (1) and in the calibration problem (2) and (3) are different. There is no argument that the classical approach is "best" for estimating α and β . In the calibration problem, the objective is the estimation of the unknown x_0 .

Brown's (1979) initial approach is to find the minimum MSE linear estimator of x_0 . He shows, however, that the MSE of a linear estimator depends on x_0 . To cope with this he proposes an unspecified distribution of future x_0 's to be estimated. After integrating the MSE over this distribution, a new minimum integrated MSE estimator (IMSE) is obtained.

Brown (1979) does not propose his minimum IMSE estimator for general use, although he notes that it could be used in some cases. He uses it as a benchmark to compare the classical and inverse estimators. When the regression line is well determined by the data, the two estimators are virtually equivalent. When the regression line is ill determined, the classical estimator is very bad. The inverse estimator will be very good if the mean of the calibration sample \bar{x} is near the expected value of the future unknown x_0 's. If the range of future x_0 's is large relative to the range of the calibration x_1 's, then the inverse estimator is very bad while the classical estimator is very good.

The previous discussion applies to point estimates. Much less is said about interval estimates for confidence intervals. Williams (1969) suggests that the two point estimators should be compared on the basis of confidence intervals. Shulka (1972), referring to this, states that it is not clear how a confidence interval can be constructed for the classical estimate. The usual method of estimating a confidence interval for α

predicted response may be applied in reverse to give a confidence interval for the inverse estimator.

Brownlee (1965) gives a confidence interval based on the classical estimation method. Naszodi (1978) refers to this interval without comment. Hoadley (1970) comments that a confidence interval for the classical estimator may be infinite. Trout and Swallow (1971) describe Scheffe confidence bounds for individual observations. They then derive uniform confidence bands over a specified range of x .

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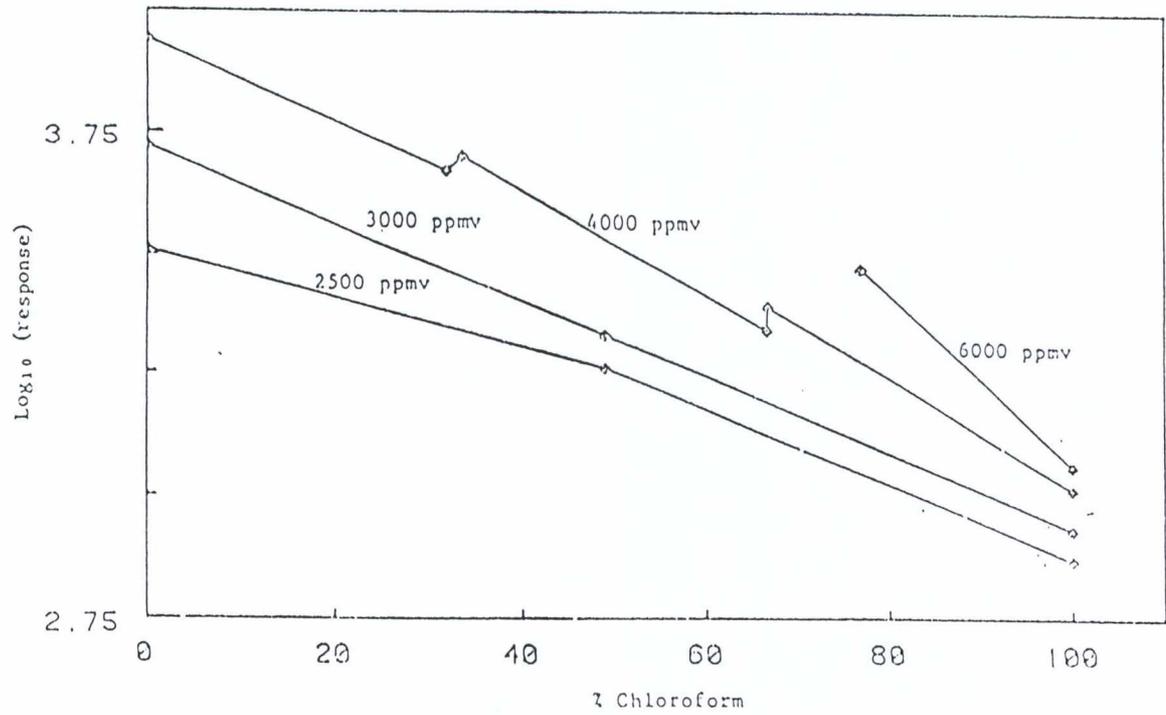


Figure 3-17. OVA Instrument Response on a Logarithmic Scale for Mixtures of Chloroform and Cyclohexane Showing Better Linearity than an Arithmetic Scale

EPA 600/2-81-110
PB-81-234-262

APPENDIX C
TYPICAL ORGANIC WASTESTREAM CONSTITUENTS

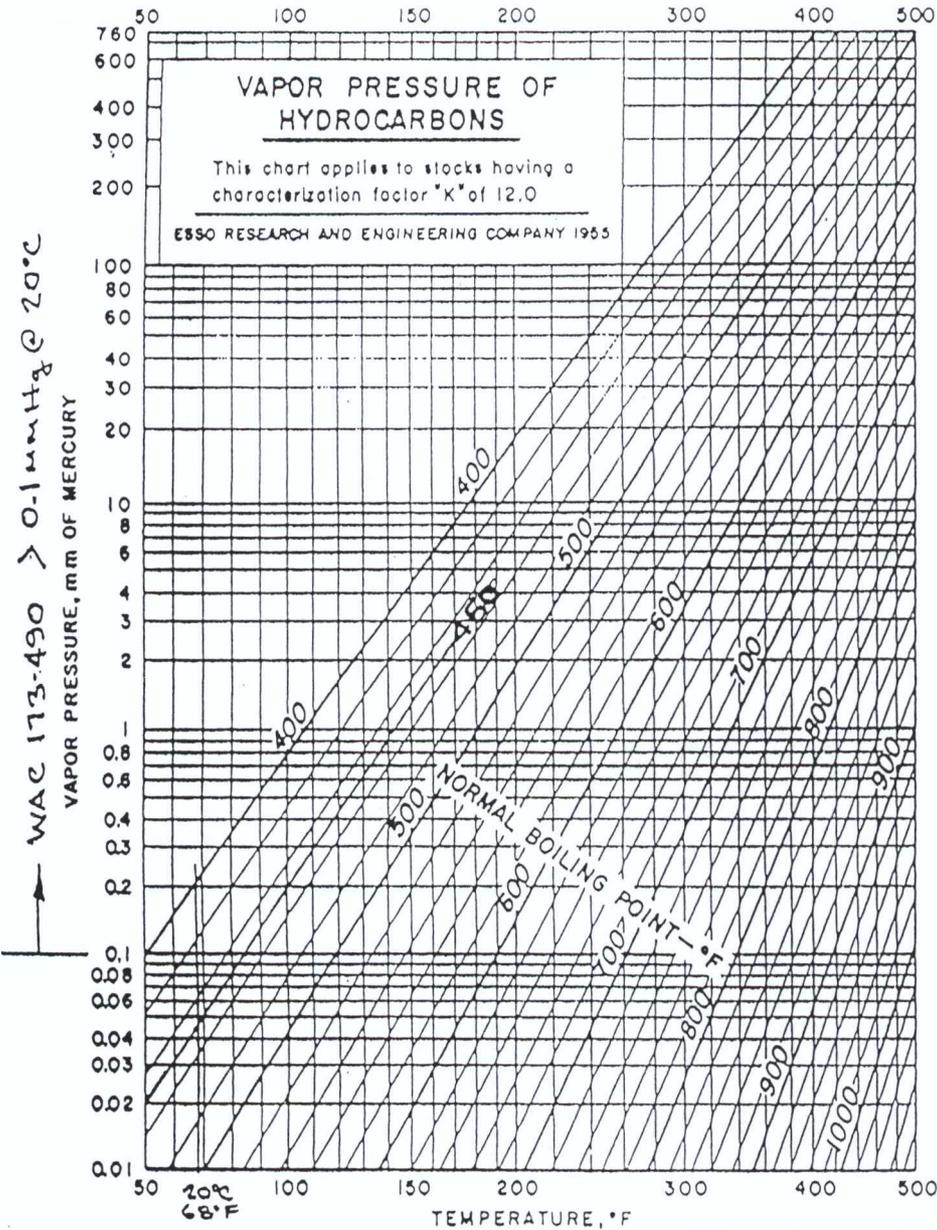


FIG. 5-25. Vapor pressure of hydrocarbon oils (low range). (Esso Research and Eng. Co.)

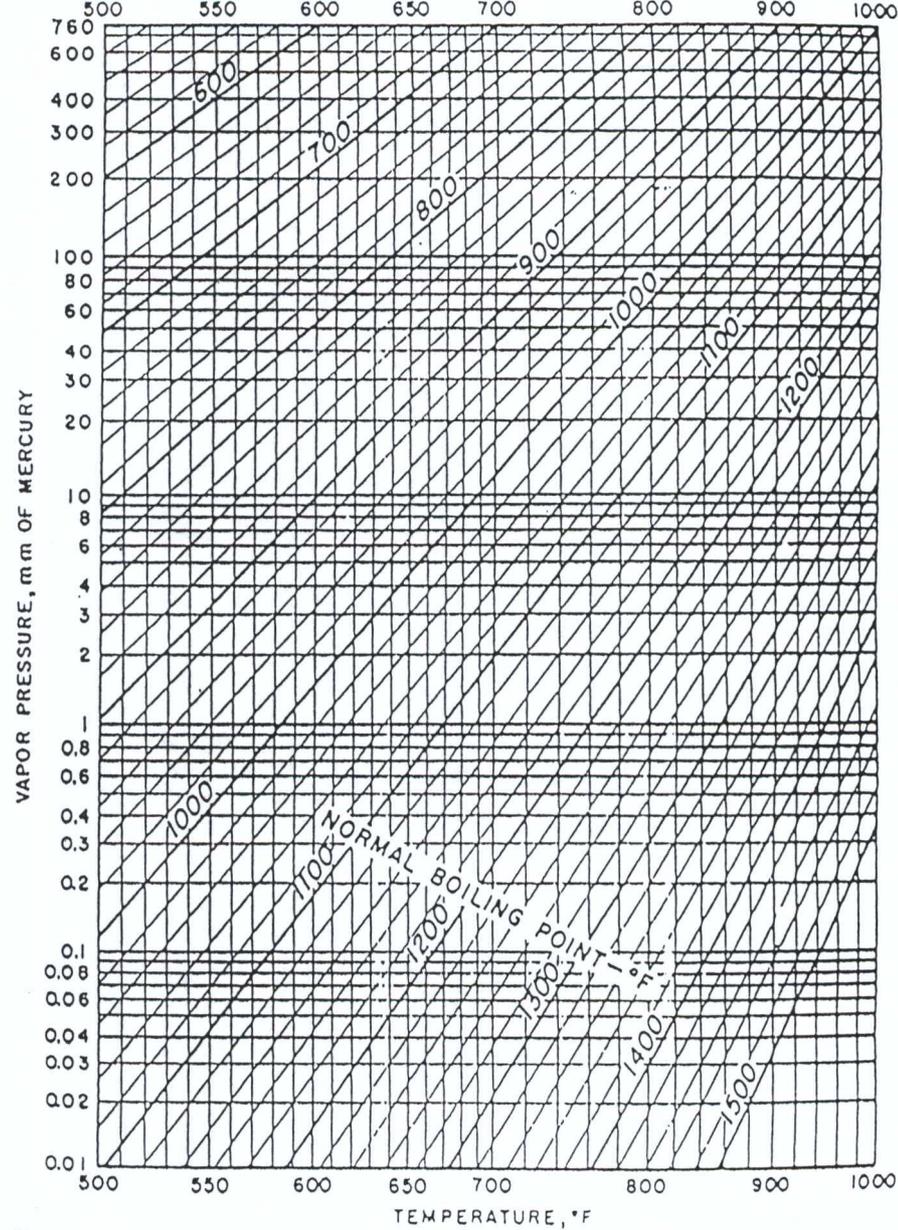


FIG. 5-26. Vapor pressure of hydrocarbon oils (high range). (Esso Research and Eng. Co.)

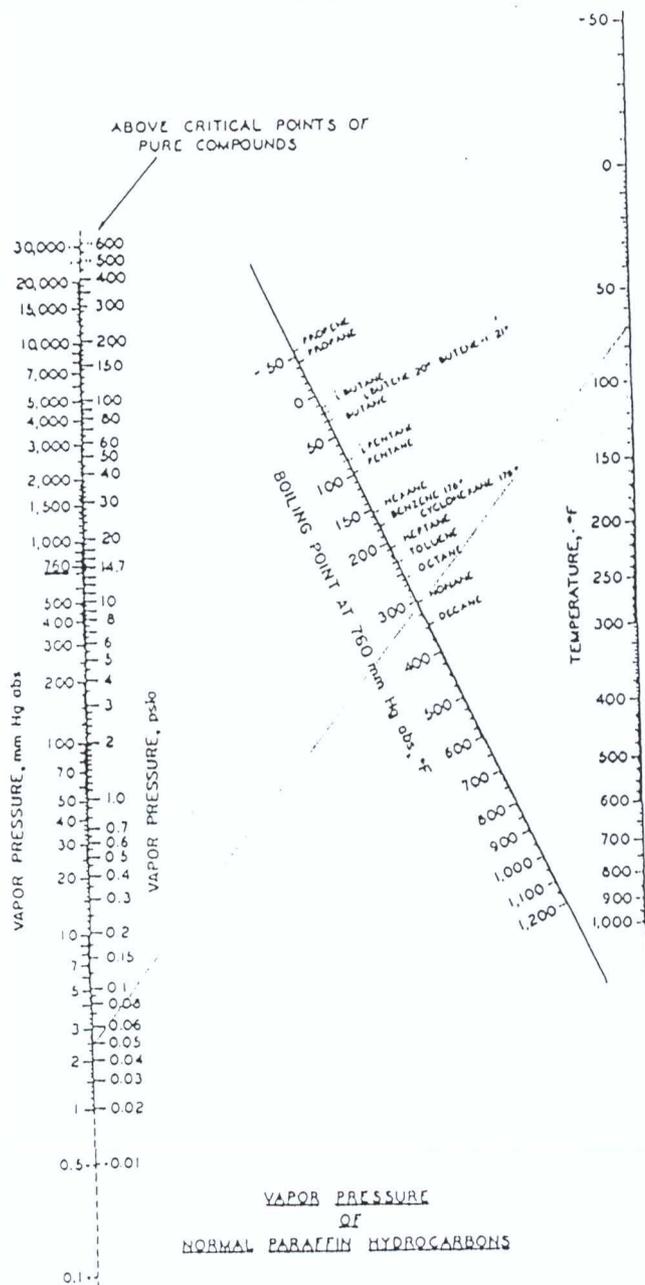


FIG. 5-27. Vapor pressure and boiling-point corrections for normal paraffin hydrocarbons and petroleum fractions.

Width of boiling range as in a petroleum fraction appears to have little effect on the change of boiling point with pressure." Inherently, the true-boiling-point type of distillation curve should correlate most exactly because it consists of the boiling points of nearly pure materials as they distill one by one. The equilibrium flash vaporization curves illustrate the other extreme type of distillation curve, and corrections of this curve from one pressure to another should not be exactly the same as the correction for fractionating distillations. Nevertheless, a large difference does not seem to exist between these two extremes of boiling-point corrections, nor does the slope of the distillation curve seem to alter the vapor-pressure or boiling-point corrections to a great extent.

Piromooov and Beiswenger¹⁰ find that the slopes of flash-vaporization curves are practically independent of pressure, so that the correction of the boiling point or flash-vaporization point is a constant number of degrees throughout the entire curve. They suggest that the correction should be determined by correcting the intersection point between the true-boiling-point curve and the flash-vaporization curve by the vapor-pressure data of the paraffin hydrocarbons. The intersection point is used because the true-boiling-point curve and the flash-vaporization curve intersect at approximately the same percentage point regardless of pressure.

Edmister, Reidel, and Mervin¹¹ have determined flash-vaporization curves on three oils up to pressures of 200 psia. They find that the higher the pressure the flatter the vaporization curve, and hence the curves at high pressures should not be drawn parallel to the atmospheric-pressure curve. Obviously, the flash curve should be horizontal at the critical pressure, and hence the slope of the flash curve will be flatter and flatter as the pressure is increased. They find that the 50 per cent atmospheric boiling point should be corrected to the new pressure by using the vapor-pressure relationship of the paraffin hydrocarbons (Fig. 5-27). In practical design computations it is common practice to convert to the new pressure by using any convenient point on the atmospheric flash-vaporization curve. Refer also to Figs. 4-22 and 15-13.

Compression or Expansion. When gases or vapors are expanded or compressed under adiabatic conditions, the amount of work done and the amount of heat required are dependent upon the ratio of the specific heat at constant pressure to the specific heat at constant volume. The expansion of a gas can always be expressed by an equation of the form

¹⁰ Nelson and Haltenberger, *Oil Gas J.*, June 11, p. 38, and June 18, p. 40, 1942.

¹¹ Equilibrium Vaporization of Oils and the Carrying Effects of Light Ends, *API Bull.* 10, no. 2, sec. II, p. 52, 1929.

¹² Equilibrium Flash Vaporization of Three Petroleum Fractions, *Trans. A.I.Ch.E.*, 39, 457 (1943).

lower than those of Table 3-1, being about 30°F below the flash point. The term "wide boiling" used in Table 3-1 refers to materials that contain small amounts of relatively low-boiling material, such as natural gasoline that contains propane, gassy or unexposed crude oil, unstripped refinery products, and asphalts that have been cut back with lighter materials.

TABLE 3-1. APPROXIMATE RELATIONSHIP BETWEEN POURING TEMPERATURE AND SUCH PROPERTIES AS VAPOR PRESSURE, FLASH POINT, AND BOILING POINT*

Reid v.p., psia	Flash point, °F	Approx. 0-10% boiling range, °F	Illustrative materials		Pouring temp., °F	
			Fractionated	Wide boiling	Fractionated	Wide boiling
45	...	.....	Nat. gaso.	Wild nat. gaso.	12	-11
40	...	.....	Nat. gaso.	Wild nat. gaso.	20	-5
35	...	.....	Nat. gaso.	Wild nat. gaso.	28	2
30	...	.....	Nat. gaso.	Wild nat. gaso.	38	9
25	...	.....	Nat. gaso.	Wild nat. gaso.	48	18
20	...	80	C ₂ -free nat. gaso.	Contains C ₂	60	26
15	...	95	C ₂ -free nat. gaso.	Contains C ₂	77	36
10	...	115	C ₂ -free nat. gaso.	Contains C ₂	100	48
8	...	125	Stable gaso.	Crude oil	112	57
6	...	140	Stable gaso.	Crude oil	123	67
4	...	160	Stable gaso.	Crude oil	140	80
2	...	190	Solvents	Unstripped	178	125
	30	215	Solvents	Unstripped	105	135
	50	245	Solvents	Unstripped	225	165
	70	275	Solvents	Unstripped	245	185
	90	305	Solvents	Unstripped	270	210
...	110	335	Kerosene	Unstripped	305	240
...	150	395	Distillates	Gas oil	365	280
...	200	475	Distillates	Fuel oil	440	330
...	250	550	Gas oil	Cutbacks	515	380
...	300	625	Fuel oil	Asphalts	585	430
...	350	700	Lube oil	Cutback asphalts	660 ^a	490
...	400	780	Lube oil	Cutback asphalts	660 ^a	540
...	500	930	Lube oil	Cutback asphalts	660 ^a	640
...	1,000		Asphalts	Cutback asphalts	660 ^a	660 ^a

* Nelson, W. L., *Oil Gas J.*, May 20, 1948, p. 239.

^a Decomposition occurs at higher temperatures.

API Gravity and Specific Gravity. Specific gravity and API (American Petroleum Institute) gravity are expressions of the density or weight of a unit volume of material. The specific gravity is the ratio of the weight of a unit volume of oil to the weight of the same volume of water at a standard temperature. Unless otherwise stated, both specific gravity and API gravity refer to these constants at 60°F. An exception is the use of 77°F (25°C) in connection with asphalts and road oils.

$$\text{Deg. API} = \frac{141.5}{\text{sp gr}} - 131.5 \quad \text{or} \quad \text{sp gr} = \frac{141.5}{\text{API} + 131.5} \quad (3-1)$$

Corresponding values of API gravity (0 to 100), specific gravity, and pounds per gallon are given in Appendix A, as well as pounds per barrel, barrels or cubic meters per long ton, etc.

The Baumé scale of gravity for liquids lighter than water, used previously by the industry, differs slightly from API gravity by the use of constants of 140 and 130 rather than 141.5 and 131.5.

Specific gravity or API gravity is measured by means of hydrometers¹ (D287), pycnometers¹ (D941 and D1217), or the chainomatic specific-gravity balance if very many small samples (15 cc) must be tested. For viscous oils or semisolid bitumens, a pycnometer (D70) or weighing bottle may be used, for solids an analytical balance (D71) equipped with a pan straddle.

Most products are sold on a basis of volume delivered corrected to 60°F by means of standard tables of volume corrections.⁴ Weight is important in determining freight rates, tanker cargoes, and the power required in pumping. Gravity or weight determines whether a product will sink or float in water or will separate from water. In other respects gravity is not of much direct significance, but the test is so simple and so widely used that it assumes importance as a means of judging many other properties and in controlling plant operations. Gravity requirements should usually be avoided in specifications.

Vapor Pressure (Reid). This test (D323)¹ is used for volatile non-viscous products such as motor gasoline and, by using a special sampling procedure, for natural gasoline of 26 lb or more vapor pressure. A modified equipment and procedure⁴ is used for liquefied petroleum gases (L.P.G.). These tests are conducted at 100°F. The ASTM vapor pressure is reported as pounds per square inch absolute pressure, whereas the L.P.G. vapor pressure is gauge pressure. The true vapor pressure is higher than the Reid vapor pressure by about 5 to 9 per cent (page 136), but this relationship varies widely.

¹ ASTM-IP Petroleum Measurement Tables, 1952.

⁴ California Natural Gasoline Association, Los Angeles, Calif., Tentative Standard Methods of Test for Liquefied Petroleum Gases, *Bull. T.S.* 441, 1945.

General Processing. The most important method of separating petroleum products is distillation, and hence the products should be compared with one another in the order of their boiling ranges. A mixed-base oil might yield products as indicated in Fig. 6-1. Figure 6-2 likewise indicates the relation among the raw materials, the intermediate refinery

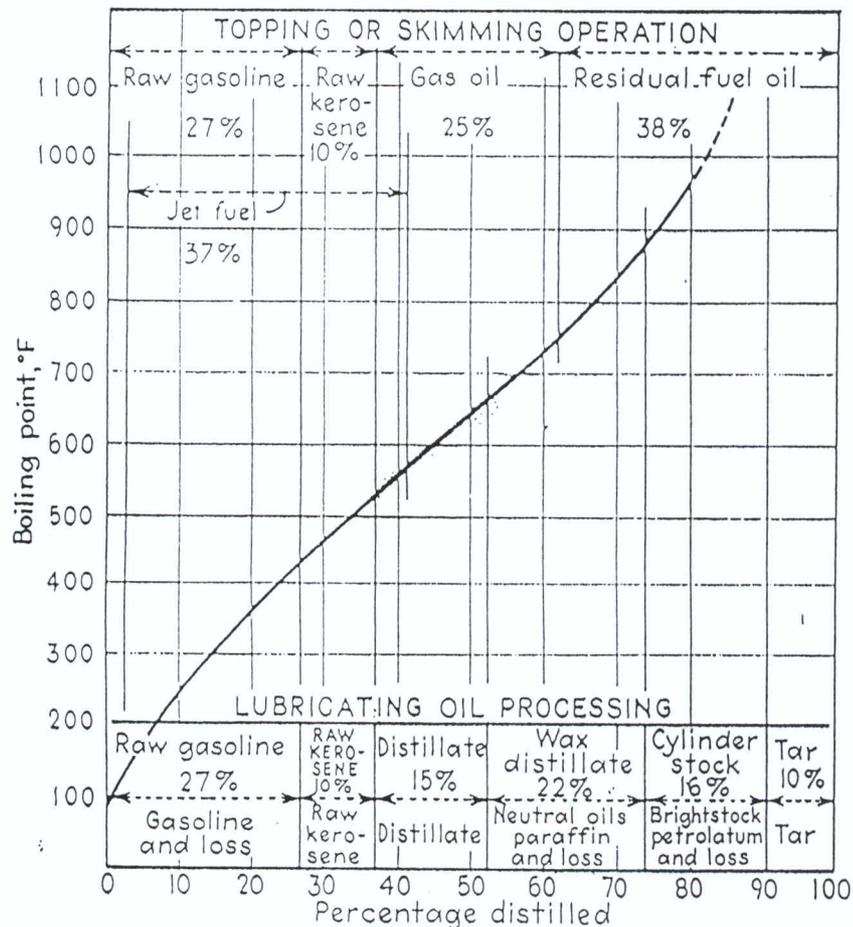


Fig. 6-1. Boiling range of refinery products (31.7 API Texas mixed-base crude oil).

stocks, and the finished market products. The dotted lines indicate products obtained by cracking. The products obtained by distillation are called "raw products," and most of them cannot be sold until they have been further refined.

Raw gasoline and raw naphtha are often treated with chemical agents such as caustic soda, copper chloride, or doctor solution. Much naphtha is now catalytically reformed into high octane gasoline. Kero-

sene usually requires only a sweetening treatment; but for fine colors, acid treatment or filtration is used. Diesel fuels, distillate fuels, gas oil, and residual fuel oil are usually sold without treatment. Pressure distillate or cracked gasoline, obtained by cracking or thermal decomposition (Fig. 6-2), is sweetened, and an inhibitor of gum formation is added. Natural gasoline, obtained from natural gas, usually requires only a sweetening treatment for the removal of hydrogen sulfide and mercaptan compounds.

Wax distillate, the raw stock for the manufacture of the light lubricating oils or neutral oil-blending stocks, contains crystalline wax. The wax is removed by chilling the distillate and filtering the wax from the oil in filter presses. Two unfinished stocks, *slack wax* and *pressed distillate*, are obtained in the pressing operation. *Neutral oils** are produced from the pressed distillate by distillation and subsequent filtration through fuller's earth. Crude scale is produced from slack wax by "sweating" or, in other words, by slowly warming the chilled slack wax so that the oil and low-melting materials, which together are called *foots oil*, melt and drain from the slack wax. Crude scale is slightly yellow in color, and this coloration may be removed by treatment with acid or caustic or by filtering the melted wax through clay. Cylinder stock is another wax-bearing product, but the wax is such that it cannot be filtered from the oil in wax presses. This so-called "amorphous wax" or *petrolatum stock* may be removed by dissolving the oil in naphtha, filtering the solution to a proper color through fuller's earth, and centrifuging the chilled solution in high-speed centrifuges. The products from this separation are solutions of *bright stock* and *petrolatum*. The naphtha is removed from the solutions by distillation, leaving finished bright stock and petrolatum.

Since 1935, the dewaxing processes described above are being replaced by the use of solvents such as methyl ethyl ketone for dewaxing both wax distillate and cylinder stock. Likewise, lubricating oils (light or heavy) are being treated with furfural, phenol, etc., for the removal of the low Viscosity Index portions. Figure 11-1 shows the relation of solvent refining to the general processing outlined in this chapter.

Cracking. Materials such as *cracking-still gas*, *pressure distillate*, *cracked gas oil*, and *pressure-still tar* are products of cracking. By cracking we refer to the decomposition of heavy or high-boiling oils by exposure to extreme temperature. At temperatures exceeding about 680°F materials such as gas oil, fuel oil, and tars are decomposed into (1) gas, (2)

* The neutral oils are often referred to as pale or red oils. In the past it was thought that part of the wax distillate had to be cracked to produce a pressable material, and the neutrals from the cracked distillate, being a deep-red color, were called "red oils." The terms have now lost their original significance, and the term "red oil" is usually reserved for any neutral oil that is darker than 3NPA.

Sensitive Stocks. Although the boiling range of a stock is an important factor, the sensitiveness of the stock to high temperatures must also be considered. All stocks start to decompose at about 680°F, yielding lower boiling products, but even lower temperatures may cause discoloration. In distilling crude oil a slight discoloration of the products (except kerosene) is not important because most of the products receive chemical treatment before they are sold. Likewise, discoloration is not important in the distillation of a reduced crude oil for the production of a gas-oil cracking stock or for the production of asphalt. However, in distilling treated pressure distillate, pressed distillate, or bright stock solution, a discoloration during distillation cannot be allowed because such products are substantially ready for marketing. If treatment follows these distillations, then the cost of the treatment will be increased by the discoloration.

High temperatures also result in a loss of heavy lubricating-oil stock. The yield of lubricating oils is often decreased by 10 to 15 per cent by the use of too high temperatures. A mild decomposition takes place in which light lubricating oil and gas oil are produced from the heavy stocks.

TABLE 7-1. VAPORIZER TEMPERATURES

Stock	Products	Temperature, °F		Pressure, psi or mm	Steam
		Vaporizer	Heater outlet		
1. Natural gasoline	Gas	210	230	120-200	No
2. Pressure distillate	Gasoline	275	325	Atmospheric	Yes
3. Crude oil	Light oils	660	710	Atmospheric	Some
4. Pressed distillate	Neutral oils	670	710	Atmospheric	Yes
5. Bright stock solution	Naphtha and neutral	670	710	Atmospheric	Yes
6. Reduced crude	Lube oils	690	730	30-80 mm	Yes
7. Fuel oil or tar	Asphalt residue	730	770	30-80 mm	Yes
8. Fuel oil or tar	Distilled cracking stock	775	850	Atmospheric	Yes

Treated pressure distillate is particularly sensitive to high temperatures. Redistillation should not be conducted at temperatures exceeding 375°F, and many refiners find that a maximum temperature of 275°F is economical because of the reduction in treating costs.

In the manufacture of asphalt most refiners limit the temperature to 770°F. Nevertheless, the temperature that may be used without ruining the ductility of the product is greatly dependent upon the characteristics of the stock and upon the manner of heating. One refiner has successfully used a temperature of 835°F at the pipestill outlet, but others have

found that 770°F was too high. If the stock is held at 835°F for more than a few minutes, extensive cracking will occur, and the operation will become a cracking process. Thus the temperature that can be attained without serious decomposition is dependent to some extent upon the time. Although a lubricating-oil stock can be heated to 710 or even 740°F in a low-absorption-rate pipestill heater, this same temperature, if maintained in a shellstill, will cause serious losses in yield and a discoloration, the removal of which may necessitate a costly chemical treatment.

Arrangement of Towers. In separating a series of products from a charge stock, three main tower arrangements are employed. Heavy-oil stocks, such as crude oil, are usually separated in a single tower, as indicated in Fig. 7-7. In such a system the feed enters somewhat low in the column, the lowest-boiling product issues from the top as a vapor, and the heavier distilled products are withdrawn from the side of the column. The small towerlike equipment shown in the center of Fig. 7-7 is not a fractionating tower. It is a series of three steam strippers set one above another. The system of Fig. 7-7 is unsatisfactory for producing highly pure products such as pure hydrocarbons because the lighter products pass the withdrawal trays of the heavier products as they proceed from the feed plate to the top. For precise separations a series of towers (one tower less than the number of products) as shown in Fig. 7-2a or b is often employed. In Fig. 7-2a the lowest boiling product is vaporized in tower No. 1 by reboiler heat at the bottom of tower No. 1, and successively higher and higher boiling materials are removed in the remaining six towers. The feed is pumped from tower to tower, each tower is cooled by refluxing a part of the overhead product into the top of the tower, and the bottom of each tower is heated by steam or a hot circulating oil by means of reboilers. Successive fractional condensation is practiced in Fig. 7-2b. Here an almost completely vaporized stock is cooled in tower No. 1 to condense the highest-boiling product, and successively lower-boiling products are condensed in the remaining six towers. The novel but little used Brugma¹ arrangement of towers shown in Fig. 7-2c employs only three towers, but the total length of the three towers is about the same as the length of the seven towers in Fig. 7-2a and b. Obviously, many combinations of these tower arrangements are possible, as in Fig. 7-8.

More material can be vaporized (at a given temperature) by a single flash vaporization than by several flashes, and hence the use of a single multidraw tower (Fig. 7-7) is better in this respect than the series arrangements of Fig. 7-2a and b. Refer to Chap. 15 for a mathematical discussion of methods of vaporization.

Steam Stripping. Steam is used to raise the flash point of most of the heavy-oil products withdrawn from the side of multidraw towers and for

¹ Ref. *Nat. Gaso. Mfr.*, September, 1941, p. 86.

MATERIAL SAFETY DATA SHEET

DIESELINE

MSDS# 093000001

ORDER# 10856 CUSTOMER: CHEMICAL PRO, W/C TAC PLANT, TACOMA, WA

HAZARD RATINGS / EMERGENCY (4 = EXTREME)

* HEALTH: MODERATE (2) * FIRE: MODERATE (2) * REACTIVITY: LEAST (0) * 24 HOUR EMERGENCY ASSISTANCE: CHEMTREC 800-424-9300 SHELL 713-473-9461 CHEMICAL SYNONYMS: DIESEL OIL CHEMICAL FAMILY: PETROLEUM HYDROCARBON SHELL CODE: 31135 CAS NUMBER: 68334-30-5

INGREDIENT COMPOSITION

100% - DIESELINE (CAS#: 68334-30-5)

HEALTH INFORMATION

THE HEALTH EFFECTS NOTED BELOW ARE CONSISTENT WITH REQUIREMENTS UNDER THE OSHA HAZARD COMMUNICATION. EYE CONTACT: BASED ON ESSENTIALLY SIMILAR PRODUCT TESTING LIQUID IS PRACTICALLY NONIRRITATING TO THE EYES. SKIN CONTACT: BASED ON ESSENTIALLY SIMILAR PRODUCT TESTING LIQUID IS PRESUMED TO BE MODERATELY IRRITATING TO THE SKIN. PROLONGED OR REPEATED LIQUID CONTACT CAN RESULT IN DEFATTING AND DRYING OF THE SKIN WHICH MAY RESULT IN SEVERE IRRITATION AND DERMATITIS. MAY CAUSE MILD SKIN SENSITIZATION. RELEASE DURING HIGH PRESSURE USAGE MAY RESULT IN INJECTION OF OIL INTO THE SKIN CAUSING LOCAL NECROSIS. INHALATION: INHALATION OF VAPORS OR MIST MAY CAUSE MILD IRRITATION TO THE UPPER RESPIRATORY TRACT. HIGH CONCENTRATIONS MAY RESULT IN CENTRAL NERVOUS SYSTEM DEPRESSION. INHALATION OF HIGH LEVELS OF MIST MAY RESULT IN CHEMICAL PNEUMONITIS. INGESTION: INGESTION OF PRODUCT MAY RESULT IN VOMITING; ASPIRATION (BREATHING) OF VOMITUS INTO THE LUNGS MUST BE AVOIDED AS EVEN SMALL QUANTITIES MAY RESULT IN ASPIRATION PNEUMONITIS. SIGNS AND SYMPTOMS: IRRITATION AS NOTED ABOVE. SKIN SENSITIZATION (ALLERGY) MAY BE EVIDENCED BY RASHES, ESPECIALLY HIVES. EARLY TO MODERATE CNS (CENTRAL NERVOUS SYSTEM) DEPRESSION MAY BE EVIDENCED BY GIDDINESS, HEADACHE, DIZZINESS AND NAUSEA; IN EXTREME CASES, UNCONSCIOUSNESS AND DEATH MAY OCCUR. LOCAL NECROSIS IS EVIDENCED BY DELAYED ONSET OF PAIN AND TISSUE DAMAGE A FEW HOURS FOLLOWING INJECTION. ASPIRATION PNEUMONITIS MAY BE EVIDENCED BY COUGHING, LABORED BREATHING AND CYANOSIS (BLuish SKIN); IN SEVERE CASES DEATH MAY OCCUR. AGGRAVATED MEDICAL CONDITIONS: PREEXISTING SKIN AND RESPIRATORY DISORDERS MAY BE AGGRAVATED BY EXPOSURE TO THIS PRODUCT. PREEXISTING SKIN OR LUNG ALLERGIES MAY INCREASE THE CHANCE OF DEVELOPING INCREASED ALLERGY SYMPTOMS FROM EXPOSURE TO THIS PRODUCT. OTHER HEALTH EFFECTS: KIDNEY DAMAGE MAY RESULT FOLLOWING ASPIRATION PNEUMONITIS. THE RESULTS OF ANIMAL BIOASSAYS ON MIDDLE DISTILLATE FUELS SHOW THAT PROLONGED DERMAL CONTACT PRODUCES A WEAK TO MODERATE CARCINOGENIC ACTIVITY. ADDITIONAL HEALTH INFORMATION: REPEATED DERMAL APPLICATION OF HIGH LEVELS OF MIDDLE DISTILLATE FUELS IN EXPERIMENTAL ANIMALS HAS PRODUCED EXTREMELY SEVERE IRRITATION TO CORROSIVE ACTION ON THE SKIN. VARYING DEGREES OF LIVER AND KIDNEY DAMAGE WERE NOTED IN THESE STUDIES, INCLUDING CONGESTION, ENLARGEMENT, MOTTLING, AND MULTIFOCAL NECROSIS. MIDDLE DISTILLATE FUELS HAVE BEEN DEMONSTRATED TO CAUSE CHROMOSOME DAMAGE IN THE IN VIVO RAT BONE MARROW CYTOGENETICS ASSAY, AND MUTAGENIC IN THE L5178Y LYMPHOMA ASSAY.

OCCUPATIONAL EXPOSURE LIMITS

NO OSHA PEL OR ACGIH TLV HAS BEEN ESTABLISHED.

EMERGENCY AND FIRST AID PROCEDURES

INHALATION: REMOVE VICTIM TO FRESH AIR AND PROVIDE OXYGEN IF BREATHING IS DIFFICULT. GET MEDICAL ATTENTION. **EYE CONTACT:** FLUSH EYES WITH WATER. IF IRRITATION OCCURS, GET MEDICAL ATTENTION. **SKIN CONTACT:** REMOVE CONTAMINATED CLOTHING/SHOES AND WIPE EXCESS FROM SKIN. FLUSH SKIN WITH WATER. FOLLOW BY WASHING WITH SOAP AND WATER. IF IRRITATION OCCURS, GET MEDICAL ATTENTION. DO NOT REUSE CLOTHING UNTIL CLEANED. IF MATERIAL IS INJECTED UNDER THE SKIN, GET MEDICAL ATTENTION PROMPTLY TO PREVENT SERIOUS DAMAGE; DO NOT WAIT FOR SYMPTOMS TO DEVELOP. **INGESTION:** DO NOT INDUCE VOMITING. IF VOMITING OCCURS SPONTANEOUSLY, KEEP HEAD BELOW HIPS TO PREVENT ASPIRATION OF LIQUID INTO THE LUNGS. GET MEDICAL ATTENTION. *NOTE TO PHYSICIAN: IF MORE THAN 2.0 ML PER KG HAS BEEN INGESTED AND VOMITING HAS NOT OCCURRED, EMESIS SHOULD BE INDUCED WITH SUPERVISION. KEEP VICTIM'S HEAD BELOW HIPS TO PREVENT ASPIRATION. IF SYMPTOMS SUCH AS LOSS OF GAG REFLEX, CONVULSIONS OR UNCONSCIOUSNESS OCCUR BEFORE EMESIS, GASTRIC LAVAGE USING A CUFFED ENDOTRACHEAL TUBE SHOULD BE CONSIDERED.

PHYSICAL DATA

BOILING POINT (DEGREES F): 325 DEG F **MELTING POINT (DEGREES F):** NOT AVAILABLE **SPECIFIC GRAVITY (H2O=1.0):** 0.8762 **VOLATILE BY VOLUME:** NOT AVAILABLE **SOLUBILITY IN WATER:** NEGLIGIBLE **EVAPORATION RATE (BUTYL ACETATE=1):** NOT AVAILABLE **VAPOR PRESSURE (MM MERCURY):** NOT AVAILABLE **VAPOR DENSITY (AIR=1.0):** <1 **APPEARANCE AND ODOR:** YELLOW LIQUID; STRONG HYDROCARBON ODOR

FIRE AND EXPLOSION HAZARDS

FLASH POINT AND METHOD USED: 130 DEG F (PMCC) MIN. **FLAMMABLE LIMITS: / % VOLUME IN AIR:** UPPER: N/A. LOWER: N/A **EXTINGUISHING MEDIA:** USE WATER FOG, FOAM, DRY CHEMICAL OR CO2. DO NOT USE A DIRECT STREAM OF WATER. PRODUCT WILL FLOAT AND CAN BE REIGNITED ON SURFACE OF WATER. **SPECIAL FIRE FIGHTING PROCEDURES:** CAUTION. COMBUSTIBLE. DO NOT ENTER CONFINED FIRE SPACE WITHOUT FULL BUNKER GEAR (HELMET WITH FACE SHIELD, BUNKER COATS, GLOVES AND RUBBER BOOTS), INCLUDING A POSITIVE PRESSURE NIOSH APPROVED SELF-CONTAINED BREATHING APPARATUS. COOL FIRE EXPOSED CONTAINERS WITH WATER. IN THE CASE OF LARGE FIRES, ALSO COOL SURROUNDING EQUIPMENT AND STRUCTURES WITH WATER. **UNUSUAL FIRE AND EXPLOSION HAZARDS:** CONTAINERS EXPOSED TO INTENSE HEAT FROM FIRES SHOULD BE COOLED WITH WATER TO PREVENT VAPOR PRESSURE BUILDUP WHICH COULD RESULT IN CONTAINER RUPTURE. CONTAINER AREAS EXPOSED TO DIRECT FLAME CONTACT SHOULD BE COOLED WITH LARGE QUANTITIES OF WATER AS NEEDED TO PREVENT WEAKENING OF CONTAINER STRUCTURE.

MATERIAL SAFETY DATA SHEET

KEROSENE 1-K (TAC)

MSDS# 012002101

ORDER# 99314 CUSTOMER: CHEMICAL PROCESSORS, W/C PLANT, TACOMA, WA, 98421

HAZARD RATINGS / EMERGENCY (4 = EXTREME)

* HEALTH: SLIGHT (1) * FIRE: MODERATE (2) * REACTIVITY: LEAST (0) * 24 HOUR EMERGENCY ASSISTANCE: LILYBLAD PETROLEUM 206-572-4402 TACOMA, WASHINGTON DISTRIBUTOR CHEMICAL FAMILY: DIESEL FUEL

INGREDIENT COMPOSITION

100% - KEROSENE 1-K (TAC) (ORAL LD50: SIMILAR PRODUCT >25 G/KG (RAT); PRACTICALLY NON-TOXIC DERMAL LD50: SIMILAR PRODUCT >3 G/KG (RABBIT); PRACTICALLY NON-TOXIC SKIN: SIMILAR PRODUCT 0.5-3.0/8.0 (RABBIT); SLIGHTLY IRRITATING EYES: SIMILAR PRODUCT 15-25/110 (RABBIT; SLIGHTLY IRRITATING)

HEALTH INFORMATION

EFFECTS OF EXPOSURE: EYES: CAUSES SLIGHT-MODERATE EYE IRRITATION. SKIN: BELIEVED TO BE SLIGHTLY IRRITATING WITH POSSIBLE REDNESS, EDEMA OR DRYING OF THE SKIN. MAY CAUSE DERMATITIS ON PROLONGED OR REPEATED CONTACT. RESPIRATORY SYSTEM: MAY CAUSE SYMPTOMS OF DROWSINESS OR NARCOSIS FROM INHALATION OF HIGH VAPOR CONCENTRATIONS. SEE ADDITIONAL COMMENTS, SECTION 11.

OCCUPATIONAL EXPOSURE LIMITS

NONE ESTABLISHED.

EMERGENCY AND FIRST AID PROCEDURES

INHALATION: SHOULD SYMPTOMS NOTED UNDER HEALTH INFORMATION (SEC. 3) OCCUR, REMOVE TO FRESH AIR. IF UNCONSCIOUS, APPLY ARTIFICIAL RESPIRATION. **EYE CONTACT:** FLUSH WITH WATER FOR 15 MINUTES. **SKIN CONTACT:** WASH EXPOSED AREAS WITH SOAP AND WATER. **INGESTION:** DO NOT INDUCE VOMITING. ASPIRATION MAY CAUSE CHEMICAL PNEUMONIA.

PHYSICAL DATA

BOILING POINT (DEGREES F): 515 **SPECIFIC GRAVITY (H2O=1.0):** 0.816 **% VOLATILE BY VOLUME:** NOT DETERMINED **SOLUBILITY IN WATER:** NOT DETERMINED **EVAPORATION RATE (BUTYL ACETATE=1):** NOT DETERMINED **VAPOR PRESSURE (MM MERCURY):** NOT DETERMINED **VAPOR DENSITY (AIR=1.0):** NOT DETERMINED **APPEARANCE AND ODOR:** CLEAR AND BRIGHT **VISCOSITY:**..... 1.20 CST @ 100 DEG F

FIRE AND EXPLOSION HAZARDS

FLASH POINT AND METHOD USED: 125 DEG F (TCC) **FLAMMABLE LIMITS / % VOLUME IN AIR:** UPPER: .58, LOWER: 4.45 **EXTINGUISHING MEDIA:** ACCORDING TO THE NATIONAL FIRE PROTECTION GUIDE 49, COMBUSTIBLE LIQUID FIRES MAY BE EXTINGUISHED BY WATER SPRAY, DRY CHEMICAL, FOAM OR CARBON DIOXIDE. **SPECIAL FIRE FIGHTING PROCEDURES:** USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL. IF A LEAK OR SPILL HAS NOT IGNITED, USE WATER SPRAY TO DISPERSE THE VAPORS AND TO PROVIDE PROTECTION FOR PERSONS ATTEMPTING TO STOP THE LEAK. **UNUSUAL FIRE AND EXPLOSION HAZARDS:** NONE.

REACTIVITY

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR **CONDITIONS AND MATERIALS TO AVOID:** THE MATERIAL REACTS VIOLENTLY WITH STRONG OXIDIZERS. MIDDLE DISTILLATES HAVE CAUSED SKIN CANCER AND KIDNEY DAMAGE IN LABORATORY ANIMALS. AVOID CONTACT WITH EYES. KEEP AWAY FROM HEAT AND FLAME. USE ONLY IN WELL-VENTILATED LOCATIONS. AVOID PROLONGED BREATHING OF MIST OR VAPOR. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP HEAD AWAY FROM CONTAINER WHEN OPENING OR DISPENSING. **HAZARDOUS DECOMPOSITION PRODUCTS:** CARBON MONOXIDE AND CARBON DIOXIDE MAY BE FORMED ON BURNING IN LIMITED AIR SUPPLY.

EMPLOYEE PROTECTION

RESPIRATORY PROTECTION: SUPPLIED AIR RESPIRATORY PROTECTION FOR CLEANING LARGE SPILLS OR UPON ENTRY INTO LARGE TANKS, VESSELS, OR OTHER CONFINED SPACES. **PROTECTIVE CLOTHING:** EXPOSED EMPLOYEES SHOULD EXERCISE REASONABLE PERSONAL CLEANLINESS; THIS INCLUDES CLEANSING EXPOSED SKIN AREAS SEVERAL TIMES DAILY WITH SOAP AND WATER, AND LAUNDERING OR DRY CLEANING SOILED WORK CLOTHING AT LEAST WEEKLY. GLOVES IMPERVIOUS TO CHEMICALS AND PETROLEUM DISTILLATES RECOMMENDED. **ADDITIONAL PROTECTIVE MEASURES:** CHEMICAL TYPE GOGGLES OR FACE SHIELD OPTIONAL. NORMAL VENTILATION REQUIRED. WASH THOROUGHLY AFTER HANDLING.

ENVIRONMENTAL PROTECTION

SPILL OR LEAK PROCEDURES: VENTILATE AREA. AVOID BREATHING VAPOR. USE SELF-CONTAINED BREATHING APPARATUS OR SUPPLIED-AIR MASK FOR LARGE SPILLS IN CONFINED AREA. CONTAIN SPILL IF POSSIBLE. WIPE UP OR ABSORB ON SUITABLE MATERIAL AND SHOVEL UP. **WASTE DISPOSAL:** RE-EVALUATION OF THE PRODUCT MAY BE REQUIRED BY THE USER AT THE TIME OF DISPOSAL, SINCE THE PRODUCT USES, TRANSFORMATIONS, MIXTURES AND PRECESSES MAY CHANGE CLASSIFICATION TO NON-HAZARDOUS OR HAZARDOUS FOR REASONS OTHER THAN, OR IN ADDITION TO, IGNITABILITY. (SEE REMARKS FOR WASTE CLASSIFICATION BELOW.) **ENVIRONMENTAL HAZARDS:** WASTE CLASSIFICATION: PRODUCT (AS PRESENTLY CONSTITUTED) HAS THE RCRA CHARACTERISTIC OF IGNITABILITY AND IF DISCARDED IN ITS PURCHASED FORM WOULD HAVE THE HAZARDOUS WASTE NUMBER D001.

SPECIAL PRECAUTIONS

CAUTION: MISUSE OF EMPTY CONTAINERS CAN BE HAZARDOUS. EMPTY CONTAINERS CAN BE HAZARDOUS IF USED TO STORE TOXIC, FLAMMABLE, OR REACTIVE MATERIALS. CUTTING OR WELDING OF EMPTY CONTAINERS MIGHT CAUSE FIRE, EXPLOSION OR TOXIC FUMES FROM RESIDUES. DO NOT PRESSURIZE OR EXPOSE TO OPEN FLAME OR HEAT. KEEP

MATERIAL SAFETY DATA SHEET

KEROSENE 1-K (TAC)

MSDS# 012002101

ORDER# 99314 CUSTOMER: CHEMICAL PROCESSORS, W/C PLANT, TACOMA, WA, 98421

CONTAINER CLOSED AND DRUM BUNGS IN PLACE. STUDIES WITH LABORATORY ANIMALS HAVE SHOWN THAT MIDDLE DISTILLATES CAUSE SKIN CANCER AND KIDNEY DAMAGE. THIS PRODUCT IS NOT INTENDED FOR SPACE HEATERS.

TRANSPORTATION REQUIREMENTS

D.O.T. CLASSIFICATION(S): COMBUSTIBLE LIQUID D.O.T. PROPER SHIPPING NAME: FUEL OIL NO. 1. DOT HAZARD CLASS (IF APPLICABLE): COMBUSTIBLE LIQUID NA1993. OTHER REQUIREMENTS: STORE AWAY FROM HEAT AND OPEN FLAME. PLACARD REQUIRED ONLY WHEN MATERIAL IS CONTAINED IN PACKAGING OR CONTAINER THAT EXCEEDS 110 GALLONS OR IN TANK CAR OR TANK TRUCK. TRANSPORT, HANDLE AND STORE IN ACCORDANCE WITH OSHA REGULATION 1910.106. AND APPLICABLE D.O.T. REGULATIONS.

OTHER REGULATORY CONTROLS

A COMPLEX MIXTURE OF ALIPHATIC, OLEFINIC, NAPHTHENIC AND AROMATIC HYDROCARBONS. THE PRINCIPAL COMPONENTS ARE ALIPHATIC HYDROCARBONS RANGING FROM C-5 TO C-16, WITH LESS THAN 20% BY VOLUME AROMATIC HYDROCARBONS. THE BOILING POINT RANGE IS 310-540 DEG F. MAXIMUM BENZENE CONTENT IS 80 PPM. UPDATED: DECEMBER 16, 1985.

MATERIAL SAFETY DATA SHEET

ROTELLA OIL 30

MSDS# 015400301

ORDER# 10991 CUSTOMER: CHEMICAL PRO, W/C TC PLANT, TACOMA, WA

HAZARD RATINGS / EMERGENCY (4 = EXTREME)

* HEALTH: SLIGHT (1) * FIRE: SLIGHT (1) * REACTIVITY: LEAST (0) * 24 HOUR EMERGENCY ASSISTANCE: SHELL 713-473-9461 CHEMTREC 800-424-9300 CHEMICAL SYNONYMS: LUBRICATING OIL CHEMICAL FAMILY: HYDROCARBON SHELL CODE: 54003 CAS NUMBER: MIXTURE

INGREDIENT COMPOSITION

100% - ROTELLA OIL 30 (NOT DETERMINED) 20-70% - SOLVENT REFINED HYDROTREATED HEAVY PARAFFINIC DISTILLATE (CAS#: 64742-54-7) 0-30% - SEVERLY HYDROTREATED HEAVY NAPHTHENIC DISTILLATE (64742-52-5) 0-30% - SOLVENT REFINED HYDROTREATED, ACID TREATED HEAVY NAPHTHENIC DIST. (64742-18-3) 0-25% - SOLVENT REFINED HYDROTREATED RESIDUAL OIL (64742-57-0) 5-10% - ADDITIVE CONTAINING ZINC DIALKYL DITHIOPHOSPHATE (THE SPECIFIC CHEMICAL IDENTITY OR % IN COMPOSITION OF THIS COMPONENT IS CONSIDERED TRADE SECRET INFORMATION.) <1% - MINOR ADDITIVE (BASED UPON DATA AVAILABLE TO SHELL. THIS PRODUCT IS NOT HAZARDOUS UNDER OSHA HAZARD COMMUNICATION (29 CFR 1910.1200).)

HEALTH INFORMATION

THE HEALTH EFFECTS NOTED BELOW ARE CONSISTENT WITH REQUIREMENTS UNDER THE OSHA HAZARD COMMUNICATION STANDARD (29 CFR 1910.1200). EYE CONTACT: LUBRICATING OILS ARE GENERALLY CONSIDERED NO MORE THAN MINIMALLY IRRITATING TO THE EYES. SKIN CONTACT: LUBRICATING OILS ARE GENERALLY CONSIDERED NO MORE THAN MILDLY IRRITATING TO THE SKIN. PROLONGED AND REPEATED CONTACT MAY RESULT IN VARIOUS SKIN DISORDERS SUCH AS DERMATITIS, FOLLICULITIS OR OIL ACNE. INHALATION: INHALATION OF VAPOR (GENERATED AT HIGH TEMPERATURES ONLY) OR OIL FROM THIS PRODUCT MAY RESULT IN MILD IRRITATION OF THE UPPER RESPIRATORY TRACT. INGESTION: LUBRICATING OILS ARE GENERALLY CONSIDERED NO MORE THAN SLIGHTLY TOXIC IF SWALLOWED. SIGNS AND SYMPTOMS: IRRITATION AS NOTED ABOVE. AGGRAVATED MEDICAL CONDITIONS: PREEXISTING SKIN AND RESPIRATORY DISORDERS MAY BE AGGRAVATED BY EXPOSURE TO THIS PRODUCT. OTHER HEALTH EFFECTS: THE INTERNATIONAL AGENCY FOR RESEARCH ON CANCER HAS DETERMINED THERE IS SUFFICIENT EVIDENCE FOR THE CARCINOGENICITY IN EXPERIMENTAL ANIMALS OF USED MOTOR OILS. HANDLING PROCEDURES AND SAFETY PRECAUTIONS IN THE MSDS SHOULD BE FOLLOWED TO MINIMIZE EMPLOYEE'S EXPOSURE TO THE USED PRODUCT. ADDITIONAL HEALTH INFORMATION: SUPPLIER OF COMPONENT 6 REPORTS THE FOLLOWING: "EPA HAS BEEN NOTIFIED OF SUBSTANTIAL RISK REPORTS UNDER TSCA SECTION 8(E) ON ZINC DITHIOPHOSPHATES BASED ON RABBIT DERMAL STUDIES AND ON IN-VITRO MUTAGENIC STUDIES. STUDIE PERFORMED AFTER THE NOTIFICATION INDICATE THAT ZINC DITHIOPHOSPHATES DO NT APPEAR TO PRESENT A SIGNIFICANT HEALTH RISK WHEN PROPER HYGIENE AND PERSONAL PROTECTION PRECAUTIONS ARE FOLLOWED."

OCCUPATIONAL EXPOSURE LIMITS

OIL MIST, MINERAL: ACGIH-TLV/TWA = 5 MG/M3, ACGIH-TLV/STEL = 10 MG/M3. OSHA-PEL/TWA = 5 MG/M3.

EMERGENCY AND FIRST AID PROCEDURES

INHALATION: REMOVE VICTIM TO FRESH AIR AND PROVIDE OXYGEN IF BREATHING IS DIFFICULT. GET MEDICAL ATTENTION. **EYE CONTACT:** FLUSH WITH WATER FOR 15 MINUTES WHILE HOLDING EYELIDS OPEN. GET MEDICAL ATTENTION. **SKIN CONTACT:** REMOVE CONTAMINATED CLOTHING AND WIPE EXCESS OFF. WASH WITH SOAP AND WATER OR A WATERLESS HAND CLEANER FOLLOWED BY SOAP AND WATER. IF IRRITATION OCCURS, GET MEDICAL ATTENTION. **INGESTION:** DO NOT INDUCE VOMITING. IN GENERAL, NO TREATMENT IS NECESSARY UNLESS LARGE QUANTITIES OF PRODUCT ARE INGESTED. HOWEVER, GET MEDICAL ATTENTION. * NOTE TO THE PHYSICIAN: IN GENERAL, EMESIS INDUCTION IS UNNECESSARY IN HIGH VISCOSITY, LOW VOLATILITY PRODUCTS, I.E., MOST OILS AND GREASES.

PHYSICAL DATA

BOILING POINT (DEGREES F): NOT AVAILABLE **MELTING POINT (DEGREES F):** -5 (POUR POINT) **SPECIFIC GRAVITY (H2O=1.0):** 0.89 **% VOLATILE BY VOLUME:** NOT AVAILABLE **SOLUBILITY IN WATER:** NEGLIGIBLE **EVAPORATION RATE (BUTYL ACETATE=1):** NOT AVAILABLE **VAPOR PRESSURE (MM MERCURY):** NOT AVAILABLE **VAPOR DENSITY (AIR=1.0):** NOT AVAILABLE **APPEARANCE AND ODOR:** DARK AMBER OIL, SLIGH HYDROCARBON ODOR.

FIRE AND EXPLOSION HAZARDS

FLASH POINT AND METHOD USED: 400 DEG F **PMCC EXTINGUISHING MEDIA:** USE WATER FOG, FOAM, DRY CHEMICAL OR CO2. DO NOT USE A DIRECT STREAM OF WATER. PRODUCT WILL FLOAT AND CAN BE REIGNITED ON SURFACE OF WATER. **SPECIAL FIRE FIGHTING PROCEDURES:** MATERIAL WILL NOT BURN UNLESS PREHEATED. DO NOT ENTER CONFINED FIRE-SPACE WITHOUT FULL BUNKER GEAR (HELMET WITH FACE SHIELD, BUNKER COATS, GLOVES AND RUBBER BOOTS), INCLUDING A POSITIVE-PRESSURE NIOSH-APPROVED SELF-CONTAINED BREATHING APPARATUS. COOL FIRE EXPOSED CONTAINERS WITH WATER. **UNUSUAL FIRE AND EXPLOSION HAZARDS:** NONE UNUSUAL

REACTIVITY

STABILITY: STABLE **HAZARDOUS POLYMERIZATION:** WILL NOT OCCUR **CONDITIONS AND MATERIALS TO AVOID:** AVOID HEAT, OPEN FLAMES AND OXIDIZING MATERIALS. **HAZARDOUS DECOMPOSITION PRODUCTS:** THERMAL DECOMPOSITION PRODUCTS ARE HIGHLY DEPENDENT ON THE COMBUSTION CONDITIONS. A COMPLEX MIXTURE OF AIRBORNE SOLID, LIQUID, PARTICULATES AND GASES WILL EVOLVE WHEN THIS MATERIAL UNDERGOES PYROLYSIS OR COMBUSTION. CARBON MONOXIDE AND OTHER UNIDENTIFIED ORGANIC COMPOUNDS MAY BE FORMED UPON COMBUSTION.

EMPLOYEE PROTECTION

RESPIRATORY PROTECTION: IF EXPOSURE MAY OR DOES EXCEED OCCUPATIONAL EXPOSURE LIMITS (SEC. 4) USE A NIOSH-APPROVED RESPIRATOR TO PREVENT OVEREXPOSURE. IN ACCORD WITH 29 CFR 1910.134 USE EITHER AN

MATERIAL SAFETY DATA SHEET

ROTELLA OIL 30

MSDS# 015400301

ORDER# 10991 CUSTOMER: CHEMICAL PRO, W/C TC PLANT, TACOMA, WA

ATMOSPHERE-SUPPLYING RESPIRATOR OR AN AIR-PURIFYING RESPIRATOR FOR ORGANIC VAPORS AND PARTICULATES. PROTECTIVE CLOTHING: WEAR CHEMICAL RESISTANT GLOVES AND OTHER PROTECTIVE CLOTHING AS REQUIRED TO MINIMIZE SKIN CONTACT. WEAR SAFETY GOGGLES TO AVOID EYE CONTACT. TEST DATA FROM PUBLISHED LITERATURE AND/OR GLOVE AND CLOTHING MANUFACTURERS INDICATE THE BEST PROTECTION IS PROVIDED BY NITRILE GLOVES.

ENVIRONMENTAL PROTECTION

SPILL OR LEAK PROCEDURES: MAY BURN ALTHOUGH NOT READILY IGNITABLE. USE CAUTIOUS JUDGMENT WHEN CLEANING UP LARGE SPILLS. LARGE SPILLS: WEAR RESPIRATOR AND PROTECTIVE CLOTHING AS APPROPRIATE. SHUT OFF SOURCE OF LEAK IF SAFE TO DO SO. DIKE AND CONTAIN. REMOVE WITH VACUUM TRUCKS OR PUMP TO STORAGE SALVAGE VESSELS. SOAK UP RESIDUE WITH AN ABSORBENT SUCH AS CLAY, SAND, OR OTHER SUITABLE MATERIALS; DISPOSE OF PROPERLY. FLUSH AREA WITH WATER TO REMOVE TRACE RESIDUE. SMALL SPILLS: TAKE UP WITH AN ABSORBENT MATERIAL AND DISPOSE OF PROPERLY. WASTE DISPOSAL: PLACE IN AN APPROPRIATE DISPOSAL FACILITY IN COMPLIANCE WITH LOCAL REGULATIONS. ENVIRONMENTAL HAZARDS: THIS PRODUCT IS CLASSIFIED AS AN OIL UNDER SEC. 311 OF THE CLEAN WATER ACT. SPILLS ENTERING (A) SURFACE WATERS OR (B) ANY WATERCOURSES OR SEWERS ENTERING/LEADING TO SURFACE WATERS THAT CAUSE A SHEEN MUST BE REPORTED TO THE NATIONAL RESPONSE CENTER, 800-424-8802.

SPECIAL PRECAUTIONS

MINIMIZE SKIN CONTACT. WASH WITH SOAP AND WATER BEFORE EATING, DRINKING, SMOKING OR USING TOILET FACILITIES. LAUNDRY CONTAMINATED CLOTHING BEFORE REUSE. PROPERLY DISPOSE OF CONTAMINATED LEATHER ARTICLES, INCLUDING SHOES, THAT CANNOT BE DECONTAMINATED. STORE IN A COOL, DRY PLACE WITH ADEQUATE VENTILATION. KEEP AWAY FROM OPEN FLAMES AND HIGH TEMPERATURES.

TRANSPORTATION REQUIREMENTS

D.O.T. CLASSIFICATION(S): NOT HAZARDOUS BY D.O.T. REGULATIONS D.O.T. PROPER SHIPPING NAME: NOT AVAILABLE OTHER REQUIREMENTS: BILL OF LADING COMMODITY DESCRIPTION: PETROLEUM LUBRICATING OIL.

OTHER REGULATORY CONTROLS

THE COMPONENTS OF THIS PRODUCT ARE LISTED ON THE EPA/TSCA INVENTORY OF CHEMICAL SUBSTANCES. THE INFORMATION CONTAINED HEREIN IS BASED ON THE DATA AVAILABLE TO US AND IS BELIEVED TO BE CORRECT. HOWEVER, SHELL MAKES NO WARRANTY, EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF. SHELL ASSUMES NO RESPONSIBILITY FOR INJURY FROM THE USE OF THE PRODUCT DESCRIBED HEREIN. DATE PREPARED: AUGUST 23, 1985.

MATERIAL SAFETY DATA SHEET

TELLUS OIL 32 (25)

MSDS# 016520801

ORDER# 10991 CUSTOMER: CHEMICAL PRO, W/C TC PLANT, TACOMA, WA

HAZARD RATINGS / EMERGENCY (4 = EXTREME)

* HEALTH: SLIGHT (1) * FIRE: SLIGHT (1) * REACTIVITY: LEAST (0) * 24 HOUR EMERGENCY ASSISTANCE: SHELL OIL COMPANY 713-473-9461 CHEMTREC 800-424-9300 CHEMICAL SYNONYMS: LUBRICATING OIL CHEMICAL FAMILY: HYDROCARBON SHELL CODE: 65208 CAS NUMBER: MIXTURE

INGREDIENT COMPOSITION

100% - TELLUS OIL 32 (25) (NOT DETERMINED) 97-98% - SOLVENT REFINED: HYDROTREATED HEAVY, PARAFFINIC DISTILLATE (CAS#: 64742-54-7) 3% - MINOR ADDITIVES (BASED UPON DATA AVAILABLE TO SHELL. THIS PRODUCT IS NOT HAZARDOUS UNDER OSHA HAZARD COMMUNICATION (29 CFR 1910.1200).)

HEALTH INFORMATION

THE HEALTH EFFECTS NOTED BELOW ARE CONSISTENT WITH REQUIREMENTS UNDER THE OSHA COMMUNICATION STANDARD (29 CFR 1910.1200). EYE CONTACT: BASED ON COMPONENT INFORMATION, PRODUCT IS PRESUMED TO BE PRACTICALLY NON-IRRITATING TO THE EYES. SKIN CONTACT: BASED ON COMPONENT INFORMATION, PRODUCT IS PRESUMED TO BE PRACTICALLY NON-IRRITATING TO THE SKIN. PROLONGED AND REPEATED CONTACT MAY RESULT IN SKIN DISORDERS SUCH AS DERMATITIS, OIL ACNE OR FOLLICULITIS. ACCIDENTAL RELEASE UNDER HIGH PRESSURE APPLICATIONS MAY RESULT IN INJECTION OF OIL INTO THE SKIN CAUSING LOCAL NECROSIS. INHALATION: THE INHALATION OF VAPORS (GENERATED AT HIGH TEMPERATURES ONLY) OR OIL MIST MAY CAUSE A MILD IRRITATION OF THE MUCOUS MEMBRANES OF THE UPPER RESPIRATORY TRACT. INGESTION: BASED ON COMPONENT INFORMATION, PRODUCT IS NO MORE THAN SLIGHTLY TOXIC IF SWALLOWED. SIGNS AND SYMPTOMS: IRRITATION AS NOTED ABOVE. NECROSIS MAY BE EVIDENCED BY ONSET OF PAIN AND TISSUE DAMAGE A FEW HOURS FOLLOWING HIGH PRESSURE INJECTION. AGGRAVATED MEDICAL CONDITIONS: PREEXISTING SKIN AND RESPIRATORY DISORDERS MAY BE AGGRAVATED BY EXPOSURE TO THIS PRODUCT.

OCCUPATIONAL EXPOSURE LIMITS

OIL MIST: ACGIH-TLV/TWA = 5 MG/M3; ACGIH-TLV/STEL = 10 MG/M3 OSHA-PEL/TWA = 5 MG/M3 (SEE NIOSH/OSHA OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS)

EMERGENCY AND FIRST AID PROCEDURES

INHALATION: REMOVE VICTIM TO FRESH AIR AND PROVIDE OXYGEN IF BREATHING IS DIFFICULT. GET MEDICAL ATTENTION. **EYE CONTACT:** FLUSH EYES WITH WATER. IF IRRITATION OCCURS, GET MEDICAL ATTENTION. **SKIN CONTACT:** REMOVE CONTAMINATED CLOTHING/SHOES, WIPE EXCESS FROM SKIN. FLUSH SKIN WITH WATER. FOLLOW BY WASHING WITH SOAP AND WATER. IF IRRITATION OCCURS, GET MEDICAL ATTENTION. IF MATERIAL IS INJECTED UNDER THE SKIN, GET MEDICAL ATTENTION PROMPTLY TO PREVENT SERIOUS DAMAGE; DO NOT WAIT FOR SYMPTOMS TO DEVELOP. **INGESTION:** DO NOT INDUCE VOMITING. IN GENERAL, NO TREATMENT IS NECESSARY UNLESS LARGE QUANTITIES OF PRODUCT ARE INGESTED. HOWEVER, GET MEDICAL ADVICE. * NOTE TO THE PHYSICIAN: IN GENERAL, EMESIS INDUCTION IS UNNECESSARY IN HIGH VISCOSITY, LOW VOLATILITY PRODUCTS, I.E., MOST OILS AND GREASES.

PHYSICAL DATA

BOILING POINT (DEGREES F): NOT AVAILABLE **MELTING POINT (DEGREES F):** -25 (POUR POINT) **SPECIFIC GRAVITY (H2O=1.0):** 0.8718 **VOLATILE BY VOLUME:** NOT AVAILABLE **SOLUBILITY IN WATER:** NEGLIGIBLE **EVAPORATION RATE (BUTYL ACETATE=1):** NOT AVAILABLE **VAPOR PRESSURE (MM MERCURY):** NOT AVAILABLE **VAPOR DENSITY (AIR=1.0):** NOT AVAILABLE **APPEARANCE AND ODOR:** CREAM WHITE LIQUID. SLIGHT HYDROCARBON ODOR.

FIRE AND EXPLOSION HAZARDS

FLASH POINT AND METHOD USED: 380 DEG F **PMCC FLAMMABLE LIMITS / % VOLUME IN AIR:** UPPER: N.A., LOWER: N.A. **EXTINGUISHING MEDIA:** USE WATER FOG, FOAM, DRY CHEMICAL OR CO2. DO NOT USE A DIRECT STREAM OF WATER. PRODUCT WILL FLOAT AND CAN BE REIGNITED ON SURFACE OF WATER. **SPECIAL FIRE FIGHTING PROCEDURES:** MATERIALS WILL NOT BURN UNLESS PREHEATED. DO NOT ENTER CONFINED FIRE SPACE WITHOUT FULL BUNKER GEAR (HELMET WITH FACE SHIELD, BUNKER COATS, GLOVES AND RUBBER BOOTS), INCLUDING A POSITIVE PRESSURE NIOSH APPROVED SELF-CONTAINED BREATHING APPARATUS. COOL FIRE EXPOSED CONTAINERS WITH WATER. **UNUSUAL FIRE AND EXPLOSION HAZARDS:** NONE UNUSUAL.

REACTIVITY

STABILITY: STABLE **HAZARDOUS POLYMERIZATION:** WILL NOT OCCUR **CONDITIONS AND MATERIALS TO AVOID:** AVOID HEAT, OPEN FLAMES, AND OXIDIZING MATERIALS. **HAZARDOUS DECOMPOSITION PRODUCTS:** THERMAL DECOMPOSITION PRODUCTS ARE HIGHLY DEPENDENT ON THE COMBUSTION CONDITIONS. A COMPLEX MIXTURE OF AIRBORNE SOLID, LIQUID, PARTICULATES AND GASES WILL EVOLVE WHEN THIS MATERIAL UNDERGOES PYROLYSIS OR COMBUSTION. CARBON MONOXIDE AND OTHER UNIDENTIFIED ORGANIC COMPOUNDS MAY BE FORMED UPON COMBUSTION.

EMPLOYEE PROTECTION

RESPIRATORY PROTECTION: IF EXPOSURE MAY OR DOES EXCEED OCCUPATIONAL EXPOSURE LIMITS (SEC. 4) USE A NIOSH-APPROVED RESPIRATOR TO PREVENT OVEREXPOSURE. IN ACCORD WITH 29 CFR 1910.134 USE EITHER AN ATMOSPHERE-SUPPLYING RESPIRATOR OR AN AIR-PURIFYING RESPIRATOR FOR ORGANIC VAPORS AND PARTICULATES. **PROTECTIVE CLOTHING:** WEAR CHEMICAL RESISTANT GLOVES AND OTHER PROTECTIVE CLOTHING AS REQUIRED TO MINIMIZE SKIN CONTACT. NO SPECIAL EYE PROTECTION IS ROUTINELY NECESSARY. TEST DATA FROM PUBLISHED LITERATURE AND/OR GLOVE AND CLOTHING MANUFACTURERS INDICATE THE BEST PROTECTION IS PROVIDED BY NITRILE GLOVES. **ADDITIONAL PROTECTIVE MEASURES:** NONE

MATERIAL SAFETY DATA SHEET

TELLUS OIL 32 (25)

MSDS# 016520801

ORDER# 10991 CUSTOMER: CHEMICAL PRO, W/C TC PLANT, TACOMA, WA

ENVIRONMENTAL PROTECTION

SPILL OR LEAK PROCEDURES: MAY BURN ALTHOUGH NOT READILY IGNITABLE. USE CAUTIOUS JUDGMENT WHEN CLEANING UP LARGE SPILLS. LARGE SPILLS: WEAR RESPIRATOR AND PROTECTIVE CLOTHING AS APPROPRIATE. SHUT OFF SOURCE OF LEAK IF SAFE TO DO SO. DIKE AND CONTAIN. REMOVE WITH VACUUM TRUCKS OR PUMP TO STORAGE/SALVAGE VESSELS. SOAK UP RESIDUE WITH AN ABSORBENT SUCH AS CLAY, SAND OR OTHER SUITABLE MATERIAL; DISPOSE OF PROPERLY. SMALL SPILLS: TAKE UP WITH AN ABSORBENT MATERIAL AND DISPOSE OF PROPERLY. WASTE DISPOSAL: PLACE IN AN APPROPRIATE DISPOSAL FACILITY IN COMPLIANCE WITH LOCAL REGULATIONS. ENVIRONMENTAL HAZARDS: THIS PRODUCT IS CLASSIFIED AS AN OIL UNDER SEC. 311 OF THE CLEAN WATER ACT. SPILLS ENTERING (A) SURFACE WATERS OR (B) ANY WATERCOURSES OR SEWERS ENTERING/LEADING TO SURFACE WATERS THAT CAUSE A SHEEN MUST BE REPORTED TO THE NATIONAL RESPONSE CENTER, 800-424-8802.

SPECIAL PRECAUTIONS

MINIMIZE SKIN CONTACT. WASH WITH SOAP AND WATER BEFORE EATING, DRINKING, SMOKING OR USING TOILET FACILITIES. LAUNDRY CONTAMINATED CLOTHING BEFORE REUSE. PROPERLY DISPOSE OF CONTAMINATED LEATHER ARTICLES, INCLUDING SHOES, THAT CANNOT BE DECONTAMINATED. STORE IN A COOL, DRY PLACE WITH ADEQUATE VENTILATION. KEEP AWAY FROM OPEN FLAMES AND HIGH TEMPERATURES.

TRANSPORTATION REQUIREMENTS

D.O.T. CLASSIFICATION(S): NOT HAZARDOUS BY D.O.T. REGULATIONS D.O.T. PROPER SHIPPING NAME: NONE OTHER REQUIREMENTS: BILL OF LADING COMMODITY DESCRIPTION - PETROLEUM LUBRICATING OIL

OTHER REGULATORY CONTROLS

THE COMPONENTS OF THIS PRODUCT ARE LISTED ON THE EPA/TSCA INVENTORY OF CHEMICAL SUBSTANCES. THE INFORMATION CONTAINED HEREIN IS BASED ON THE DATA AVAILABLE TO US AND IS BELIEVED TO BE CORRECT. HOWEVER, SHELL MAKES NO WARRANTY, EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF. SHELL ASSUMES NO RESPONSIBILITY FOR INJURY FROM THE USE OF THE PRODUCT DESCRIBED HEREIN. DATA PREPARED: AUGUST 29, 1985.

MATERIAL SAFETY DATA SHEET

ROTELLA OIL 10W

MSDS# 015400101

ORDER# 10991 CUSTOMER: CHEMICAL PRO, W/C TC PLANT, TACOMA, WA

HAZARD RATINGS / EMERGENCY (4 = EXTREME)

* HEALTH: SLIGHT (1) * FIRE: SLIGHT (1) * REACTIVITY: LEAST (0) * 24 HOUR EMERGENCY ASSISTANCE: SHELL
713-473-9461 CHEMTREC 800-424-9300 CHEMICAL SYNONYMS: LUBRICATING OIL CHEMICAL FAMILY: HYDROCARBON;
MOTOR OIL SHELL CODE: 54001 CAS NUMBER: MIXTURE

INGREDIENT COMPOSITION

100% - ROTELLA OIL 10W (NOT DETERMINED) 90-95% - SOLVENT REFINED HYDROTREATED HEAVY PARAFFINIC DISTILLATE (CAS#: 64742-54-7) 5-10% - ADDITIVE CONTAINING ZINC DIALKYL DITHIOPHOSPHATE (MIXTURE *THE SPECIFIC CHEMICAL IDENTITY OR PERCENT IN COMPOSITION OF COMPONENT 2 IS CONSIDERED TRADE SECRET INFORMATION.) <1% - MINOR ADDITIVE (MIXTURE BASED ON DATA AVAILABLE TO SHELL. COMPONENT 4 IN THIS PRODUCT IS NOT HAZARDOUS UNDER OSHA HAZARD COMMUNICATION (29 CFR 1910.1200).)

HEALTH INFORMATION

EYE: LUBRICATING OILS ARE GENERALLY CONSIDERED NO MORE THAN MINIMALLY IRRITATING TO THE EYES. SKIN: LUBRICATING OILS ARE GENERALLY CONSIDERED NO MORE THAN MILDLY IRRITATING TO THE SKIN. PROLONGED AND REPEATED CONTACT MAY RESULT IN VARIOUS SKIN DISORDERS SUCH AS DERMATITIS, FOLLICULITIS OR OIL ACNE. INHALATION: INHALATION OF VAPOR (GENERATED AT HIGH TEMPERATURES ONLY) OR OIL MIST FROM THIS PRODUCT MAY RESULT IN MILD IRRITATION OF THE UPPER RESPIRATORY TRACT. INGESTION: LUBRICATING OILS ARE GENERALLY CONSIDERED NO MORE THAN SLIGHTLY TOXIC IF SWALLOWED. SIGNS AND SYMPTOMS: IRRITATION AS NOTED ABOVE. AGGRAVATED MEDICAL CONDITIONS: PREEXISTING SKIN AND RESPIRATORY DISORDERS MAY BE AGGRAVATED BY EXPOSURE TO THIS PRODUCT. OTHER HEALTH EFFECTS: THE INTERNATIONAL AGENCY FOR RESEARCH ON CANCER HAS DETERMINED THERE IS SUFFICIENT EVIDENCE FOR THE CARCINOGENICITY IN EXPERIMENTAL ANIMALS OF USED MOTOR OILS. HANDLING PROCEDURES AND SAFETY PRECAUTIONS IN THE MSDS SHOULD BE FOLLOWED TO MINIMIZE EMPLOYEE'S EXPOSURE TO THE USED PRODUCT. SUPPLEMENTAL HEALTH INFORMATION: SUPPLIER OF COMPONENT 3 REPORTS THE FOLLOWING: "EPA HAS BEEN NOTIFIED OF SUBSTANTIAL RISK REPORTS UNDER TSCA SECTION 8(E) ON ZINC DITHIOPHOSPHATES BASED ON RABBIT DERMAL STUDIES AND ON IN-VITRO MUTAGENIC STUDIES. STUDIES PERFORMED AFTER THE NOTIFICATION INDICATE THAT ZINC DITHIOPHOSPHATES DO NOT APPEAR TO PRESENT A SIGNIFICANT HEALTH RISK WHEN PROPER HYGIENE AND PERSONAL PROTECTION PRECAUTIONS ARE FOLLOWED."

OCCUPATIONAL EXPOSURE LIMITS

OIL MIST, MINERAL OSHA - PEL/TWA = 5 MG/M3 ACGIH - TLV/TWA = 5 MG/M3 TLV/STEL = 10 MG/M3

EMERGENCY AND FIRST AID PROCEDURES

INHALATION: REMOVE VICTIM TO FRESH AIR AND PROVIDE OXYGEN IF BREATHING IS DIFFICULT. GET MEDICAL ATTENTION. **EYE CONTACT:** FLUSH WITH WATER FOR 15 MINUTES WHILE HOLDING EYELIDS OPEN. GET MEDICAL ATTENTION. **SKIN CONTACT:** REMOVE CONTAMINATED CLOTHING AND WIPE EXCESS OFF. WASH WITH SOAP AND WATER OR A WATERLESS HAND CLEANER FOLLOWED BY SOAP AND WATER. IF IRRITATION OCCURS, GET MEDICAL ATTENTION. **INGESTION:** DO NOT INDUCE VOMITING. IN GENERAL NO TREATMENT IS NECESSARY UNLESS LARGE QUANTITIES OF PRODUCT ARE INGESTED. HOWEVER, GET MEDICAL ATTENTION. *NOTE TO PHYSICIAN: IN GENERAL, EMESIS INDUCTION IS UNNECESSARY IN HIGH VISCOSITY, LOW VOLATILITY PRODUCTS, I.E., MOST OILS AND GREASES.

PHYSICAL DATA

BOILING POINT (DEGREES F): NOT AVAILABLE **MELTING POINT (DEGREES F):** NOT AVAILABLE **SPECIFIC GRAVITY (H2O=1.0):** 0.88 **VOLATILE BY VOLUME:** NOT AVAILABLE **SOLUBILITY IN WATER:** NEGLIGIBLE **EVAPORATION RATE (BUTYL ACETATE=1):** NOT AVAILABLE **VAPOR PRESSURE (MM MERCURY):** NOT AVAILABLE **VAPOR DENSITY (AIR=1.0):** NOT AVAILABLE **APPEARANCE AND ODOR:** DARK AMBER OIL. SLIGHT ODOR

FIRE AND EXPLOSION HAZARDS

FLASH POINT AND METHOD USED: 365 DEG F (PMCC) **FLAMMABLE LIMITS / % VOLUME IN AIR:** UPPER: N/A. LOWER: N/A **EXTINGUISHING MEDIA:** USE WATER FOG, FOAM, DRY CHEMICAL OR CO2. DO NOT USE A DIRECT STREAM OF WATER. PRODUCT WILL FLOAT AND CAN BE REIGNITED ON SURFACE OF WATER. **SPECIAL FIRE FIGHTING PROCEDURES:** MATERIAL WILL NOT BURN UNLESS PREHEATED. DO NOT ENTER CONFINED FIRE-SPACE WITHOUT FULL BUNKER GEAR (HELMET WITH FACE SHIELD, BUNKER COATS, GLOVES AND RUBBER BOOTS), INCLUDING A POSITIVE-PRESSURE NIOSH-APPROVED SELF-CONTAINED BREATHING APPARATUS. COOL FIRE EXPOSED CONTAINERS WITH WATER. **UNUSUAL FIRE AND EXPLOSION HAZARDS:** NONE UNUSUAL

REACTIVITY

STABILITY: STABLE **HAZARDOUS POLYMERIZATION:** WILL NOT OCCUR **CONDITIONS AND MATERIALS TO AVOID:** AVOID HEAT, OPEN FLAMES AND OXIDIZING MATERIALS. **HAZARDOUS DECOMPOSITION PRODUCTS:** THERMAL DECOMPOSITION PRODUCTS ARE HIGHLY DEPENDENT ON THE COMBUSTION CONDITIONS. A COMPLEX MIXTURE OF AIRBORNE SOLID, LIQUID, PARTICULATES AND GASES WILL EVOLVE WHEN THIS MATERIAL UNDERGOES PYROLYSIS OR COMBUSTION. CARBON MONOXIDE AND OTHER UNIDENTIFIED ORGANIC COMPOUNDS MAY BE FORMED UPON COMBUSTION.

EMPLOYEE PROTECTION

RESPIRATORY PROTECTION: IF EXPOSURE MAY OR DOES EXCEED OCCUPATIONAL EXPOSURE LIMITS (SECTION 4) USE A NIOSH-APPROVED RESPIRATOR TO PREVENT OVEREXPOSURE. IN ACCORD WITH 29 CFR 1910.134 USE EITHER AN ATMOSPHERE-SUPPLYING RESPIRATOR OR AN AIR-PURIFYING RESPIRATOR FOR ORGANIC VAPORS AND PARTICULATES. **PROTECTIVE CLOTHING:** WEAR CHEMICAL RESISTANT GLOVES AND OTHER PROTECTIVE CLOTHING AS REQUIRED TO

MATERIAL SAFETY DATA SHEET

ROTELLA OIL 10W

MSDS# 015400101

ORDER# 10991 CUSTOMER: CHEMICAL PRO, W/C TC PLANT, TACOMA, WA

MINIMIZE SKIN CONTACT. WEAR SAFETY GOGGLES TO AVOID EYE CONTACT. TEST DATA FROM PUBLISHED LITERATURE AND/OR GLOVE AND CLOTHING MANUFACTURERS INDICATE THE BEST PROTECTION IS PROVIDED BY NITRILE GLOVES.

ENVIRONMENTAL PROTECTION

SPILL OR LEAK PROCEDURES: MAY BURN ALTHOUGH NO READILY IGNITABLE. USE CAUTIOUS JUDGMENT WHEN CLEANING UP LARGE SPILLS. LARGE SPILLS: WEAR RESPIRATOR AND PROTECTIVE CLOTHING AS APPROPRIATE. SHUT OFF SOURCE OF LEAK IF SAFE TO DO SO. DIKE AND CONTAIN. REMOVE WITH VACUUM TRUCKS OR PUMP TO STORAGE SALVAGE VESSELS. SOAK UP RESIDUE WITH AN ABSORBENT SUCH AS CLAY, SAND, OR OTHER SUITABLE MATERIALS; DISPOSE OF PROPERLY. FLUSH AREA WITH WATER TO REMOVE TRACE RESIDUE. SMALL SPILLS: TAKE UP WITH AN ABSORBENT MATERIAL AND DISPOSE OF PROPERLY. **WASTE DISPOSAL:** PLACE IN AN APPROPRIATE DISPOSAL FACILITY IN COMPLIANCE WITH LOCAL REGULATIONS. **ENVIRONMENTAL HAZARDS:** THIS PRODUCT IS CLASSIFIED AS AN OIL UNDER SECTION 311 OF THE CLEAN WATER ACT. SPILLS ENTERING (A) SURFACE WATERS OR (B) ANY WATER COURSES OR SEWERS ENTERING/LEADING TO SURFACE WATERS THAT CAUSE A SHEEN MUST BE REPORTED TO THE NATIONAL RESPONSE CENTER, 800-424-8802.

SPECIAL PRECAUTIONS

MINIMIZE SKIN CONTACT. WASH WITH SOAP AND WATER BEFORE EATING, DRINKING, SMOKING OR USING TOILET FACILITIES. LAUNDRY CONTAMINATED CLOTHING BEFORE REUSE. PROPERLY DISPOSE OF CONTAMINATED LEATHER ARTICLES, INCLUDING SHOES, THAT CANNOT BE DECONTAMINATED. STORE IN A COOL, DRY PLACE WITH ADEQUATE VENTILATION. KEEP AWAY FROM OPEN FLAMES AND HIGH TEMPERATURES.

TRANSPORTATION REQUIREMENTS

D.O.T. CLASSIFICATION(S): NOT HAZARDOUS BY D.O.T. REGULATIONS **D.O.T. PROPER SHIPPING NAME:** NOT AVAILABLE **OTHER REQUIREMENTS:** BILL OF LADING COMMODITY DESCRIPTION: PETROLEUM LUBRICATING OIL

OTHER REGULATORY CONTROLS

THE COMPONENTS OF THIS PRODUCT ARE LISTED ON THE EPA/TSCA INVENTORY OF CHEMICAL SUBSTANCES. THE INFORMATION CONTAINED HEREIN IS BASED ON THE DATA AVAILABLE TO US AND IS BELIEVED TO BE CORRECT. HOWEVER, SHELL MAKES NO WARRANTY, EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF. SHELL ASSUMES NO RESPONSIBILITY FOR INJURY FROM THE USE OF THE PRODUCT DESCRIBED HEREIN. DATE PREPARED: AUGUST 23, 1985

MOBIL OIL CORPORATION MATERIAL SAFETY DATA BULLETIN

***** I. PRODUCT IDENTIFICATION *****
MOBIL OTE OIL LIGHT

SUPPLIER: MOBIL OIL CORP.
CHEMICAL NAMES AND SYNONYMS: PET. HYDROCARBONS AND ADDITIVES
USE OR DESCRIPTION: LUBRICANT

HEALTH EMERGENCY TELEPHONE: (212) 983-4411
TRANSPORT EMERGENCY TELEPHONE: (800) 424-9300 (CHEMTREC)

***** II. TYPICAL CHEMICAL AND PHYSICAL PROPERTIES *****

APPEARANCE: ASTM 1.0 LIQUID ODOR: MILD PH: NA
VISCOSITY AT 100 F, SUS: 158.0 AT 40 C, CS: 30.4
VISCOSITY AT 210 F, SUS: 25.7 AT 100 C, CS: 5.1
FLASH POINT F(C): 425(218) (ASTM D-92)
MELTING POINT F(C): NA POUR POINT F(C): 20(-7)
BOILING POINT F(C): > 600(316)
RELATIVE DENSITY, 15/4 C: 0.868 SOLUBILITY IN WATER: NEGLIGIBLE
VAPOR PRESSURE-MM HG 20C: < .1

NA=NOT APPLICABLE NE=NOT ESTABLISHED D=DECOMPOSES
FOR FURTHER INFORMATION, CONTACT YOUR LOCAL MARKETING OFFICE.

***** III. INGREDIENTS *****

WT PCT (APPROX)	EXPOSURE LIMITS (MG/M3)	SOURCES (PPM AND NOTES)
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HAZARDOUS INGREDIENTS:
NONE

OTHER INGREDIENTS:
REFINED MINERAL OILS >95
ADDITIVES AND/OR OTHER INGREDIENTS < 5

KEY TO SOURCES: A=ACGIH-TLV, A*=SUGGESTED-TLV, M=MOBIL, O=OSHA
NOTE: LIMITS SHOWN FOR GUIDANCE ONLY. FOLLOW APPLICABLE REGULATIONS.

***** IV. HEALTH HAZARD DATA *****

EFFECTS OF OVEREXPOSURE: SLIGHT SKIN IRRITATION.

***** V. EMERGENCY AND FIRST AID PROCEDURES *****

EYE CONTACT: FLUSH WITH WATER.
SKIN CONTACT: WASH CONTACT AREAS WITH SOAP AND WATER.
INHALATION: NOT EXPECTED TO BE A PROBLEM.
INGESTION: NOT EXPECTED TO BE A PROBLEM WHEN INGESTED. IF UNCOMFORTABLE SEEK MEDICAL ASSISTANCE.

***** VI. FIRE AND EXPLOSION HAZARD DATA *****

FLASH POINT F(C): 425(218) (ASTM D-92)
FLAMMABLE LIMITS. LEL: .6 UEL: 7.0
EXTINGUISHING MEDIA: CARBON DIOXIDE, FOAM, DRY CHEMICAL AND WATER FOG.
SPECIAL FIRE FIGHTING PROCEDURES: FIREFIGHTERS MUST USE SELF-CONTAINED BREATHING APPARATUS.
UNUSUAL FIRE AND EXPLOSION HAZARDS: NONE
NFPA HAZARD ID: HEALTH: 0, FLAMMABILITY: 1, REACTIVITY: 0

LUB-001

E. F. HOUGHTON & CO.
P. O. BOX 930 VALLEY FORGE, PA. 19482 * (215) 666-4103

MATERIAL SAFETY DATA SHEET

REV DATE: 030789

824000 MACHINE TOOL CLEANER

SECTION I-PRODUCT IDENTIFICATION

PRODUCT NAME: MACHINE TOOL CLEANER
PROPER SHIPPING NAME: CLEANING COMPOUND, LIQUID

HAZARD CLASS: NON-HAZARDOUS
HAZARD ID NO: N/A
CHEMICAL FAMILY: MIXTURE
COMPLETED BY: DAVID H EADLINE
PHONE NUMBER: 215-666-4103
MFG. DUNS #: 00-224-1800

SECTION II-HAZARDOUS COMPONENTS

MATERIAL	CAS NO	PERCENT	HAZARD
DEODORIZED KEROSENE	8008-20-6	1-10	TLV: 200 PPM REL: NONE
DIPROPYLENE GLYCOL METHYL ETHER	34570-94-2	1-10	TLV: 100 PPM REL: 100 PPM STEL: 150 PPM

(PRODUCT USE DILUTION: 4-8%)

SECTION III-PHYBICAL DATA

BOIL. PT. (DEG F): 215
VAPOR PRESSURE (MM HG) LIKE WATER
VAPOR DENSITY (AIR = 1) LIKE WATER
PERCENT VOLATILE: 30-60
PH NEAT: 10.2 PH AT 5.0%: 10.1
APPEARANCE AND ODOR:
CLEAR AMBER LIQUID; FAINT MINT ODOR
SPECIFIC GRAVITY: 0.98
EVAP RATE: LIKE WATER
SOL IN WATER: SOLUBLE

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT, DEG. F (METHOD USED): N/A
NFPA CLASSIFICATION HEALTH: 0 FIRE: 0 REACTIVITY: 0
EXTINGUISHING MEDIA:
N/A - CONTAINS WATER
SPECIAL FIRE FIGHTING INSTRUCTIONS:
IF WATER BOILS OFF, USE CARBON DIOXIDE, FOAM, DRY CHEMICAL
UNUSUAL FIRE AND EXPLOSION HAZARDS:
NONE
LEL: N/A UEL: N/A

CONTINUED ON PAGE 2

FAX No. 223 - 7791

Material Safety Data Sheet
 May be used to comply with
 OSHA's Hazard Communication Standard,
 29 CFR 1910.1200. Standard must be
 consulted for specific requirements.

U.S. Department of Labor
 Occupational Safety and Health
 (Non-Mandatory Form)

IDENTITY (As Used on Label and List)
 TRIM® SOL

Note: Blank spaces are not permitted. If any item is not applicable, or no
 information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name MASTER CHEMICAL CORPORATION	Emergency Telephone Number 419-874-7902
Address (Number, Street, City, State, and ZIP Code) 501 West Boundary	Telephone Number for Information 419-874-7902
Perrysburg, OH 43551	Date Prepared 9-86
	Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Petroleum oil	5 mg/m ³ (mist)	5 mg/m ³ (mist)	none	30-40
Petroleum sulfonate	none	none	none	20-30
Chlorinated alkene polymer ✓	none	none	none	20-30
Nonionic surfactant	none	none	none	1-10
Organic alcohol	none	none	none	1-10
Glycols	none	none	none	1-10
Silicone defoamer	none	none	none	<1
Water	none	none	none	Balance

The exact chemical identities and percentages of the raw materials used in TRIM® SOL are trade secrets. This information is being withheld as provided for in the Occupational Safety and Health Administration's Hazard Communication Rule (29 CFR 1910.1200).

Section III — Physical/Chemical Characteristics

Boiling Point	217°F	Specific Gravity (H ₂ O - 1)	1.004
Vapor Pressure (mm Hg.)	<1	Melting Point	not determined
Vapor Density (AIR - 1)	not determined	Evaporation Rate (Butyl Acetate - 1)	1
Solubility in Water	100%		

Appearance and Odor

Dark green viscous liquid with mild, pleasant odor.

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	305°F (COC) None (TCC)	Flammable Limits	LEL	UEL
Extinguishing Media	As appropriate for the surrounding fire.		not determined	
Special Fire Fighting Procedures	None			

Additional Fire and Explosion Hazards

None

V

MATERIAL SAFETY DATA SHEET
BLASER SWISSLUBE INC.

SECTION I: Product Identification

MANUFACTURER: Blaser & Co Ltd. CH-3415 Hasle - Ruegsau, Switzerland
ADDRESS: Blaser Swissslube, Inc. Westgate Industrial Park
Goshen, NY 10924
PRODUCT NAME: BLASOCUT 4000 STRONG Art. No. 872
EMERGENCY TELEPHONE NO: (914) 294-3200
PRODUCT TYPE: Water Soluble Metal Working Coolant (Mineral oil based)

SECTION II: Product Composition

Blasocut 4000 Strong is a nonhazardous mixture of severely hydrotreated mineral oil; anionic emulsifiers; chlorinated paraffins; polar additives; corrosion and fungi inhibitors; odorant and dye (technical grade of food dye) and a stabilizer consisting of Na-benzoate; 2,3-pentandiol, 2-methyl; Ca-acetate; alpha-Tocopherol; citric acid; tartaric acid; ascorbic acid; ascorbylpalmitate; oleylsarkosid; 1-hydroxyethyl-2-oleyl-imidazolin; glycerin

Blasocut 4000 Strong DOES NOT CONTAIN: Phenols, Nitrites, formaldehydes or formaldehyde releasing substances, heavy metals (such as Lead, Mercury etc.), active sulfur, arsenic, PCB, PCT, TCDD or other Dioxin related substances. PCA content less than 10 ppm (GC)

SECTION III: Chemical and Physical Properties of the Complete Product

Boiling point: 572F | Pour point: -22F | Specific gravity: 0.976 @ 68F
Vapor pressure: Not volatile
Solubility in water: 100%
pH @ 5% : fresh 8.9 24 hrs 8.7
Volatiles, % vol: nil
Appearance and odor: Green | pleasant odor (almonds)

SECTION IV: Fire and Explosion Hazard Data

Flash Point: 366F (Cleveland open) | Explosion Limits: not applicable
Auto Ignition Temperature: >572F
Products formed under ABNORMAL conditions: Thermal decomposition of the concentrate above 176F: trace amounts of HCl
Unusual Fire or Explosion Hazards: none
Special Fire Fighting Procedures: none
Fire fighting Media: CO₂, dry chemical, foam

CUTZOL WS-5050
Multi-purpose Heavy Duty Soluble Oil

HAZARDOUS INGREDIENTS	%	TLV
Pigments:	0	0
Catalysts:	0	0
Vehicles: Mineral oil	53	0
Solvents:	0	0
Metals:	0	0
Other: Chlorinated paraffins, sulfonates, amines	47	n/a

II. PHYSICAL DATA

Boiling point (°F): 330°F
 Vapor pressure (mm of Hg): 0
 Vapor density (Air=1): Unknown
 Specific gravity: 1.021
 Percent volatile (volume): 0
 Evaporation rate (n-Butyl acetate=1): 0
 Solubility in water: forms emulsion
 Odor & appearance: Dark green liquid with lemony odor

III. FIRE AND EXPLOSION HAZARD DATA

Flash point; COC (°F): 330°F
 Flammable limits: Not applicable
 Extinguishing media: Foam, dry chemical, CO₂
 Special fire fighting procedures: Use air supplied breathing apparatus in enclosed areas.
 Unusual fire & explosion hazards: None

IV. HEALTH HAZARD DATA

Threshold limit value: 5 mg/mm³ as an oil mist
 Effects of overexposure: Not established, but exercise caution.

IV. HEALTH HAZARD DATA (cont'd.)

Emergency first aid procedures:
 Eyes - flush with copious amounts of saline solution Ingestion - do not induce vomiting -- call physician

V. REACTIVITY DATA

Stability: Stable
 Conditions to avoid: None

Incompatibility: Strong oxidants

Hazardous decomposition: Incomplete combustion yields CO plus HCL

VI. SPILL & DISPOSAL DATA

Spill procedures: Use oil absorbant material
 Waste disposal methods: By incineration or contract

VII. SPECIAL PROTECTION INFORMATION

Respiratory: None
 Ventilation: None
 Eye protection: Goggles
 Skin protection: In individual cases
 Special protection: None

VIII. SPECIAL PRECAUTIONS

Handling & storage: Keep from open flame
 Other precautions: None

EMBRGENCY TELEPHONE NO.

(203) 792-0052

MOBIL OIL CORPORATION MATERIAL SAFETY DATA BULLETIN

REVISED: 09/20/87

***** I. PRODUCT IDENTIFICATION *****
MOBIL OTE 26

SUPPLIER: MOBIL OIL CORP. HEALTH EMERGENCY TELEPHONE: (212) 383-4411
CHEMICAL NAMES AND SYNONYMS: PET. HYDROCARBONS AND ADDITIVES TRANSPORT EMERGENCY TELEPHONE: (800) 424-9300 (CHEMTREC)
USE OR DESCRIPTION: HYDRAULIC OIL

***** II. TYPICAL CHEMICAL AND PHYSICAL PROPERTIES *****

APPEARANCE: ASTM 4.0 LIQUID DGR: MILD PH: NA
VISCOSITY AT 100 F, SUS: 335.0 AT 40 C, CS: 65.0
VISCOSITY AT 210 F, SUS: 52.7 AT 100 C, CS: 3.0
FLASH POINT F(C): 400(204) (ASTM D-92)
MELTING POINT F(C): NA POUR POINT F(C): -5(-21)
BOILING POINT F(C): > 600(316)
RELATIVE DENSITY, 15/4 C: 0.87 SOLUBILITY IN WATER: NEGLIGIBLE
VAPOR PRESSURE-MM HG 20C: < .1
NA=NOT APPLICABLE NE=NOT ESTABLISHED D=DECOMPOSES
FOR FURTHER INFORMATION, CONTACT YOUR LOCAL MARKETING OFFICE.

***** III. INGREDIENTS *****

	WT PCT (APPROX)	EXPOSURE LIMITS (MG/M3)	SOURCES (PPM AND NOTES)
HAZARDOUS INGREDIENTS:			
NONE			
OTHER INGREDIENTS:			
REFINED MINERAL OILS		>95	
ADDITIVES AND/OR OTHER INGREDIENTS		< 5	

SEE SECTION XII FOR COMPONENT REGULATORY INFORMATION.

SOURCES: A=ACGIH-TLV, A*=SUGGESTED-TLV, M=MOBIL, O=OSHA, S=SUPPLIER
NOTE: LIMITS SHOWN FOR GUIDANCE ONLY. FOLLOW APPLICABLE REGULATIONS.

***** IV. HEALTH HAZARD DATA *****

--- INCLUDES AGGRAVATED MEDICAL CONDITIONS, IF ESTABLISHED ---
EFFECTS OF OVEREXPOSURE: NOT EXPECTED TO BE A PROBLEM.

***** V. EMERGENCY AND FIRST AID PROCEDURES *****

--- FOR PRIMARY ROUTES OF ENTRY ---
EYE CONTACT: FLUSH WITH WATER.
SKIN CONTACT: WASH CONTACT AREAS WITH SOAP AND WATER.
INHALATION: NOT EXPECTED TO BE A PROBLEM.
INGESTION: NOT EXPECTED TO BE A PROBLEM. HOWEVER, IF GREATER THAN 1/2 LITER (PINT) INGESTED, IMMEDIATELY GIVE 1 TO 2 GLASSES OF WATER AND CALL A PHYSICIAN, HOSPITAL EMERGENCY ROOM OR POISON CONTROL CENTER FOR ASSISTANCE. DO NOT INDUCE VOMITING OR GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

2/1/89

SECTION I: Product Identification

MANUFACTURER: Blaser & Co Ltd. CH-3415 Hasle - Rueggau, Switzerland
ADDRESS: Blaser Swissslube, Inc. Westgate Industrial Park
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6% of virgin product

Blasocut 4000 Strong DOES NOT CONTAIN: Phenols, Nitrites, formaldehydes or formaldehyde releasing substances, heavy metals (such as Lead, Mercury etc.), active sulfur, arsenic, PCB, PCY, TCDD or other Dioxin related substances. PCA content less than 10 ppm (GC)

SECTION III: Chemical and Physical Properties of the Complete Product

Boiling point: 572F | Pour point: -22F | Specific gravity: 0.976 @ 68F
Vapor pressure: Not volatile
Solubility in water: 100%
pH @ 5% fresh 8.9 24 hrs 8.7
Volatiles, % vol: nil
Appearance and odor: Green | pleasant odor (almonds)

Assumes 20% Ref. 201

SECTION IV: Fire and Explosion Hazard Data

Flash Point: 366F (Cleveland open) | Explosion Limits: not applicable
Auto Ignition Temperature: 572F
Products formed under ABNORMAL conditions: Thermal decomposition of the concentrate above 176F: trace amounts of HCl
Unusual Fire or Explosion Hazards: none
Special Fire Fighting Procedures: none
Fire fighting Media: CO2, dry chemical, foam

Blaser
1-914-294-3200

MATERIAL SAFETY DATA SHEET

PAGE 3

DIESELINE

MSDS NUMBER: 400018

ORDER: 75900 CUSTOMER: 3CH061409 CHEMICAL PRO

SECTION VI PHYSICAL DATA

BOILING POINT (DEGREES F.):	325 - 700 DEG F	MELTING POINT (DEGREES F.):	
SPECIFIC GRAVITY (H ₂ O = 1):	AP 0.84 - 0.88	% VOLATILE BY VOLUME:	
SOLUBILITY IN WATER:	NEGLIGIBLE	EVAPORATION RATE (BUTYL ACETATE=1):	N/AP
VAPOR PRESSURE (MM MERCURY):	0.1 (REID-PSIA AT 100	VAPOR DENSITY (AIR = 1):	

APPEARANCE AND ODOR: LIGHT YELLOW TO AMBER COLORED LIQUID; KEROSENE ODOR.

SECTION VII FIRE AND EXPLOSION HAZARDS

FLASH POINT AND METHOD USED - AP 135 DEG F (D-93)	FLAMMABLE LIMITS / % VOLUME IN AIR LOWER: 0.6	UPPER: 7.5
--	--	------------

EXTINGUISHING MEDIA: FOAM, DRY CHEMICAL HALON, CARBON DIOXIDE, WATER FOG.

SPECIAL FIRE FIGHTING PROCEDURES: FOR FIRES INVOLVING THIS MATERIAL, DO NOT ENTER ANY ENCLOSED OR CONFINED FIRE SPACE WITHOUT PROPER PROTECTIVE EQUIPMENT, INCLUDING SELF-CONTAINED BREATHING APPARATUS. COOL TANKS AND CONTAINERS EXPOSED TO FIRE WITH WATER.

UNUSUAL FIRE AND EXPLOSION HAZARDS: MODERATELY COMBUSTIBLE! WHEN HEATED ABOVE THE FLASH POINT, THIS MATERIAL WILL RELEASE FLAMMABLE VAPORS WHICH IF EXPOSED TO AN IGNITION SOURCE CAN BURN IN THE OPEN OR BE EXPLOSIVE IN CONFINED SPACES. MISTS OR SPRAYS MAY BE FLAMMABLE AT TEMPERATURES BELOW THE NORMAL FLASH POINT.

SECTION VIII REACTIVITY

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS AND MATERIALS TO AVOID: HEAT, SPARKS, OPEN FLAME AND OTHER IGNITION SOURCES. REACTS WITH STRONG ACIDS, STRONG OXIDIZING MATERIALS AND ALKALIES.

*** CONTINUED ON NEXT PAGE ***

ESELINE

MSDS NUMBER: 400018

ORDER: 75162 CUSTOMER: 3CH061409 CHEMICAL PROCESSORS

SECTION VI PHYSICAL DATA

BOILING POINT (DEGREES F.):	325 - 700 DEG F	MELTING POINT (DEGREES F.):	
SPECIFIC GRAVITY (H ₂ O = 1):	AP 0.84 - 0.88	% VOLATILE BY VOLUME:	
SOLUBILITY IN WATER:	NEGLIGIBLE	EVAPORATION RATE (BUTYL ACETATE=1):	N/AP
VAPOR PRESSURE (MM MERCURY):	<0.1 (REID-PSIA AT 100	VAPOR DENSITY (AIR = 1):	

APPEARANCE AND ODOR: LIGHT YELLOW TO AMBER COLORED LIQUID; KEROSENE ODOR.

SECTION VII FIRE AND EXPLOSION HAZARDS

FLASH POINT AND METHOD USED - 135 DEG F (D-93)	FLAMMABLE LIMITS / % VOLUME IN AIR LOWER: 0.6 UPPER: 7.5
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EXTINGUISHING MEDIA: FOAM, DRY CHEMICAL HALON, CARBON DIOXIDE, WATER FOG.

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UNUSUAL FIRE AND EXPLOSION HAZARDS: MODERATELY COMBUSTIBLE! WHEN HEATED ABOVE THE FLASH POINT, THIS MATERIAL WILL RELEASE FLAMMABLE VAPORS WHICH IF EXPOSED TO AN IGNITION SOURCE CAN BURN IN THE OPEN OR BE EXPLOSIVE IN CONFINED SPACES. MISTS OR SPRAYS MAY BE FLAMMABLE AT TEMPERATURES BELOW THE NORMAL FLASH POINT.

SECTION VIII REACTIVITY:

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS AND MATERIALS TO AVOID: HEAT, SPARKS, OPEN FLAME AND OTHER IGNITION SOURCES. REACTS WITH STRONG ACIDS, STRONG OXIDIZING MATERIALS AND ALKALIES.

*** CONTINUED ON NEXT PAGE ***